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NEW YORK, APRIL, 1895.

EDITORIAL NOTES.

THE international exhibition seems to be the order of the day. Even before the Chicago Exhibition was fairly under way, France announced the undertaking of another, and pre-empted the year 1900 for that purpose; then hardly had the gates of the White City been closed before the Midwinter Fair at San Francisco was in full blast. Antwerp followed last summer, and Atlanta is now in the throes of preparation for the Cotton Exposition of the coming fall. Then the *débris* will hardly have ceased to attract attention before Mexico will have opened her first show, provided things move as the promoters wish. This invasion of the Spanish American countries by the international exhibition has not yet been fully decided, but it is safe to say that the country having once been inoculated, the fever will not be allayed until it has run its course and ended in a fizzle or a success.

THE discussion on Rapid Transit by the Mechanical Engineers of New York seemed to swing around the civil engineering portions of the problem, and only at the latter portion of the discussion was the expense of operation touched upon. Each speaker seemed to take it for granted that the coming rapid transit railroad must be constructed *de novo*, and that an increase in the facilities of the present roads could be ignored. As a matter of fact, the West Side lines of the Manhattan are capable of a considerable increase in capacity. Even with the present third-track facilities, express trains run from Rector to One Hundred and Twenty-fifth Street in 29 minutes; and were the third track to be extended down Greenwich Street to Franklin, the time could probably be reduced to 20 minutes, and by running through trains over the Putnam Division of the New York Central & Hudson River Railroad it would be possible to run from Yonkers to Rector Street in 40 minutes. Five car trains running on 1½ minutes' headway would provide for 160 seated passengers per minute, which would afford a great relief to the local trains, and cut down very materially the number of standing passengers who take the cars below One Hundred and Fourth Street or above Franklin. The structure is strong enough to carry the extra track, and we understand that the plans are prepared; but unless the stories told by the railroad officials are very far from the facts, the city authorities have interposed every conceivable obstacle to the laying of this third line of rails.

THE interesting correspondence which we publish in another column suggests and probably explains the reason why steel tubes have shown a more rapid corrosion than iron in steam boilers. It would add greatly to the information which we have upon the subject of boiler corrosions if some one would carry out a series of experiments to determine whether there is any basis to the assumption that metal corrodes more rapidly when under a tensile than when subjected to a compression strain. It has been suggested that this is the reason why the tubes of water-tube boilers corrode more rapidly than those of fire-tubes, and there seems to be some good reason why this should be so; but we are not aware that any one has investigated the question to such an extent as to be able to state whether a tensile strain actually does promote corrosion, or whether the theory that it does is merely a shrewd guess to account for a known phenomenon.

THE NARROW-GAUGE DELUSION.

THE English papers for some months past have been filled with discussions, reports of conferences, and communications on the subject of "light railways." The public in England seems to be agitated on the subject of providing better facilities of transportation for the rural districts of that country, with the hope that such facilities may do something to relieve the agricultural distress, which prevails there as it does in other parts of the world. The question of the relation of the gauge to the cost of construction and operation of light railroads is again very warmly discussed, and the same old arguments that did service in the old "battle of the gauges" of half a century ago, and again in the later one 25 years afterward, are repeated, and are disputed as warmly now as they were then. Few are now living who remember the earlier battle, and since the later controversy a new generation of engineers and railroad men have come on the field, who know little or nothing of either campaign. A retrospective view may therefore have some interest, especially to our younger readers.

The first "battle of the gauges," as it was called, was fought about 1845, and the question at issue then was, whether gauges *wider* than 4 ft. 8½ in. were more advantageous than the latter; but in 1870 the issue was between the 4 ft. 8½ in. and narrower gauges. We have before us the Report of the Commissioners appointed by Parliament to "inquire into the Gauge of Railways," with the minutes of evidence taken before the Commissioners. This forms a large volume of 850 pages, which if one had an unlimited amount of time would make very interesting reading. When this report was made some of the English roads were of the standard 4 ft. 8½ in. gauge, while others were of 6 ft., and the Great Western 7-ft. gauge. For the latter it was claimed:

1. That the cost of the locomotive power is reduced by using engines of large power and capacity for steam.
2. That such power can only be obtained to the required extent, and be economically applied by the adoption of the broad (7-ft.) gauge.

3. That higher speeds can be, and are, obtained by the broad gauge, and with greater loads.
4. That the plant necessary to work a given amount of traffic is less costly, in proportion to the amount of such traffic, in the first instance, and there is a corresponding less dead weight carried.
5. That by the use of larger and heavier carriages, and the greater width of base, there is greater security, as well as superior accommodation, with the means of combining the conveyance of all classes by the quick trains, which has not been found practicable on any narrow-gauge line.

In his testimony before the Commission, Mr. Brunel, the Engineer of the Great Western Railway, said that he "would rather be above than under 7 ft. now, if he had to reconstruct the line." But notwithstanding all the evidence which was brought forward in favor of the wide gauge, the decision of the Commissioners and of subsequent events was against gauges wider than 4 ft. 8½ in.

About 1870, however, Mr. R. F. Fairlie read a paper before the British Association on "The Gauge for Railways of the Future," which to a very great extent was based upon the proposition which he announced that "the proportion of non-paying to paying weight (as far as this is independent of management) is increased exactly in proportion as the rails are further apart, because a ton of materials disposed upon a narrow gauge is stronger as regards its carrying power than the same weight when spread over a wider basis." Now if this proposition was true, it would follow, logically, that a bicycle or a wheelbarrow would be imponderable. From the hypothesis—for it was nothing more—which we have quoted, Mr. Fairlie attempted to show that railroads with gauges narrower than 4 ft. 8½ in. would have immense advantages, and be much more economical to construct and to operate than standard gauge roads. He set forth his arguments in a very alluring way. His paper was republished in every part of the world, and his assumptions and conclusions were, with one exception, generally accepted by all the engineering and railroad papers in this and in other countries. The paper created a furore everywhere. It appeared at a time when the investing public had become distrustful of railroad securities, and it at once was taken hold of by projectors, promotors, and schemers of every degree of veracity and mendacity. The new doctrine was proclaimed in defiance of the laws of statics and gravitation, and the pill was swallowed by investors, many of whom were very much nauseated thereafter. A great many narrow-gauge roads were projected and built in this and in other countries. Here nearly all of them have since been changed to standard gauge at great cost and an immense waste of money.

The exception among the papers referred to above was the *Railroad Gazette*, of which the writer was then an editor. It republished Mr. Fairlie's paper, with a criticism of it, pointing out that his new mechanical principle was a fallacy and his conclusion nonsense, and that the gauge of a railroad had very little and within practical limits perhaps *no* influence on the weight of rolling stock. Week after week that paper pointed out the errors and delusions of the advocates of the narrow gauge. Their facts were disputed and their arguments dislocated, but still those who "were convinced against their will were of the same opinion still," and kept on building narrow-gauge roads, until the irresistible logic of events made the delusion apparent and the bubble burst. During all this period the paper referred to stood like a stone wall, exposed the fallacies of the advocates of the new system, resisted the obloquy and the ridicule which was heaped upon it by its contemporaries, and the promoters of the "new system." The technical press of the whole world were unanimous in their acceptance of the new plan of railroad salvation, which, like the road which leads heavenward, they insisted must be a narrow path. The *Railroad Gazette* was then the only paper to dissent from the new faith, which was preached so zealously and practised extensively. Which was right and which were wrong events have since decided. In the light of the experience in this and other countries, it seems strange to see the old well-worn and threadbare facts and arguments again paraded, with all their tatters, in the papers of to-day. Recalling the controversy of a quarter of a century ago, the fallacies of that day have a sort of mouldy flavor when they are repeated in print, as they have been in late English papers. A short review of the arguments used in the old controversy may be entertaining and perhaps profitable to some readers.

It may be said, as a preliminary observation, that no argument is needed to prove that a wide-gauge road laid with heavy rails and equipped with heavy rolling stock will be more expensive than a narrow-gauge line with light rails and light rolling stock. In England the question which is now being discussed anew is whether the cost of light roads will be materially less if the gauge is made 2 or 3 ft. instead of 4 ft. 8½ in.?

Mr. Fairlie's fundamental proposition, and it was accepted by most of the narrow-gauge disciples, was that "the proportion of non-paying weight is increased exactly in proportion as the rails are further apart." On this hypothesis, if we let W represent the non-paying weight, G the gauge, and n an undetermined quantity, we will have

$$W = G \times n.$$

For a 3-ft. gauge $W = 3 \times n,$
and for a 6-ft. gauge $W = 6 \times n.$
But for a single-rail line $W = 0 \times n = 0,$
which proves that, as remarked before, a bicycle and a wheelbarrow would have no non-paying weight, or be imponderable.

The question may also be considered in a different way. Let it be supposed that fig. 1 represents a side view of a freight box-car for a 3 ft.-gauge road, and that fig. 2 represents an end view of this car. It will be supposed, further, that the body, B, is made of such dimensions, weight, and strength as are best suited for the traffic on a light, narrow-gauge line. The width, it will be assumed, is double the gauge, or 6 ft., and the length, 28 ft., although any other dimensions may be adopted if they are desirable. Now, suppose that such a body, instead of being carried on two 3-ft. gauge trucks, or "bogies," is mounted on trucks of 4 ft. 8½ in. gauge; obviously the carrying capacity, strength, and weight of the body will be the same in each case, so that neither gauge will have the advantage so far as the body is concerned. It is also plain that the wheels and side or longitudinal frames of the trucks could be the same, and would have the same carrying capacity on either gauge. The only difference in the trucks will be in the length, size, and weight of the transverse members—that is, the axles, bolsters, transoms, and brake-beams. These, being longer, must also be of larger cross-section and consequently heavier. The weight of the car would be increased only in those parts, which would be very little. Whatever it is should be credited to the narrow gauge; but there should be an entry on the other side. It is generally considered inadvisable to make a car-body of a greater width than double the gauge. This principle will limit the width of the car-body on the narrow gauge to 6 ft., but on the wide gauge it might be made more, say 8 ft. The aggregate length of the sides and ends which enclose the 6-ft. body is 68 ft.; the floor area, 168 sq. ft., so that each foot in length of what we will call the walls of the car encloses 2.47 sq. ft. of floor area. In the 8-ft. body the length of the walls is 72 ft., and each foot encloses 3.11 sq. ft. of floor. It will thus be seen that the wider body will be lighter in proportion to its carrying capacity than the narrower one. The argument would be just as applicable to cars carried on four wheels, as English "wagons" are, as it is to "bogie" rolling stock. It sometimes seems, though, as if a surgical operation were required to get into the heads of narrow-gauge advocates the idea that light cars and engines may be used on standard

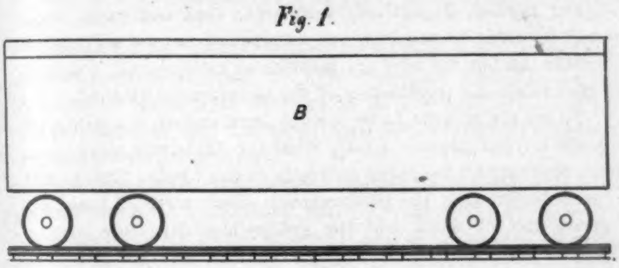
gauge roads. That they can be is shown by the fact that the lightest cars which are used—those for horse railroads—are almost invariably made of standard gauge.

Locomotives need hardly be discussed. All that requires to be said is that with the same capacity, the same sized boiler, cylinders, and wheels the difference in weight will be almost inappreciable, and the price will be the same. Any locomotive builder who understands his business will confirm this statement, and any of them will build engines of the same capacity, size and weight for the same price for either gauge.

If, then, the rolling stock is of the same weight, the rails need not be any heavier on a wide than on a narrow-gauge road; all arguments based upon the assumption that lighter rails can be used on the one gauge than on the other are simply imbecile.

But it was and is still argued by some that the width of cuts and embankments may be less with a narrow-gauge than with a wide one. Let us analyze this claim. If a road is to be cheap it will be unballasted, and the sleepers or cross-ties will rest directly on the earth. On such yielding material there must be sufficient bearing surface to carry a given weight. If the weight of the rolling stock is the same on each gauge, the bearing surface and consequently the length of the sleepers may be the same. When 3-ft. gauge roads were first built in this country, sleepers 6 ft. long were laid,

Fig. 1.



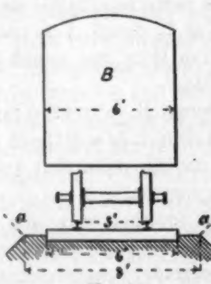


Fig. 2.

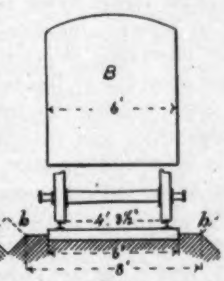


Fig. 3.

but it was soon found that on what is not inappropriately called a mud road, that in order to get sufficient stability their length had to be increased. It may be assumed as a fact that a 3-ft. gauge road cannot be operated satisfactorily with sleepers shorter than 6 ft. Now it is quite practicable to lay a 4 ft. 8½ in. gauge road on 6-ft. ties, as shown in fig. 3, and if they are made longer than that, as experience has shown is essential, we approximate to what has been common practice on many of our earlier and cheaper 4 ft. 8½-in. gauge lines in this country. In other words, the length of the sleepers does not depend upon the gauge, but on the load they must carry.

It is also true that the width of embankments is not governed by the gauge, but by the length of the sleepers. If the latter must be as long for the one gauge as for the other, the embankments may be of the same width for each.

But the narrow-gaugers say you can run around sharper curves if the rails are near together than is possible if they are wider apart; and, as a writer in *The Times*, Mr. Calthorp, said some time ago, "the direct saving of a narrow gauge as regards earthwork occurs through the greater flexibility of its alignment, which enables it to wind in and out, to avoid the severance of valuable property, deep cuttings, heavy embankments, and, if required, to follow all the convolutions of an ordinary road." The force of this argument depends upon the main assumption, which is that you can run around sharper curves with a narrow gauge than with a wide one, which is denied. The shortness of the radius of curvature is dependent upon other considerations, and not on the gauge, and, as a matter of fact, it is not true that curves of shorter radius are used on narrow-gauge roads than on those of the standard distance between the rails. Mr. Calthorp, who was formerly employed on a road in India, in the same article from which we have already quoted says that the minimum radius of curvature on the main lines of 5 ft. 6-in. gauge roads, in that country, is 1,600 ft.; on metre-gauge roads, 1,000 ft.; on 2 ft. 6-in. gauge, 250 ft.; on 2-ft. gauge, 150 ft. On the New York Elevated railroads, which are 4 ft. 8½-in. gauge, and on which more trains are run per day than on any other road in the world, there are curves of 90 ft. radius on the main line, and all trains must and do run over them. It is, therefore, not true that shorter curves are used on narrow than on wide-gauge roads, and all arguments based on such an assumption fall to the ground.

In his article in *The Times*, Mr. Calthorp says further: "It is a well-known fact among locomotive engineers, that on the same gradients a narrow-gauge locomotive, in proportion to its weight, can haul a larger load than a standard-gauge engine, the advantage being still more noticeable when the gradient occurs on a severe curve." This illusion, it was thought, vanished 25 years ago, when it did duty, and we were accustomed to it; but to see it in print again leads one to doubt the observation that the "world do move." Some evidence ought to be brought forward to show why the law of gravitation acts differently on a narrow than it does on a wide gauge before this statement can be accepted.

It may, in conclusion, be asserted with great positiveness: 1. That neither rolling stock nor rails can be lighter or cheaper for narrow than for wide-gauge railroads *for the same kind of service*. 2. The sleepers for rolling stock of a given weight must have the same amount of bearing surface and be of the same length for both gauges. 3. The embankments must therefore be of the same width. 4. Narrow-gauge cars and locomotives do not run around sharper curves than those of standard gauge do, and therefore narrow-gauge roads have no greater "flexibility of alignment" than wide ones. 5. The law of gravitation acts in the same way on rails placed 4 ft. 8½ in. apart as it does when they are 3 ft. or not so far apart, and therefore a locomotive of a given weight will pull as much on the one gauge as it will on the other. 6. The idea that placing the rails nearer together lessens the cost of construction, lightens the rolling stock, and diminishes the expense of operating a railroad is an exploded delusion. 7. A road for light traffic can be built and operated as cheaply, if made of the standard gauge, as it can if the rails are placed nearer together. This is proved by the fact that horse and electric roads are almost universally made of the standard gauge. 8. If rails are laid on common roads, it is important that two horses may be able to travel side by side between the rails, which they cannot do if the rails are nearer together than 4 ft. 8½ in. 9. It is fatuitous to cite the difference in cost between wide-gauge roads, with heavy rails and rolling stock, expensive stations, and other equipment, and that of narrow-gauge lines with light rails, light cars, light engines, and cheap stations, signals, etc., and reason therefrom that the difference is due to the gauge. It would be just as unreasonable to take the difference in cost between a big house built on a wide street, and compare it with that of a small house

on a narrow street, and infer therefrom that it is much cheaper to build houses on narrow streets than on wide ones. 10. Some thousands of miles of light 3-ft. gauge railroads were built in this country, nearly all of which have been changed to the standard gauge at much cost and inconvenience, which ought to be a conclusive argument.

"LOCOMOTIVE RETURNS."

In February, 1892, we commenced the publication of the tabular "locomotive returns," which have been published each month since that time. In announcing our intention of publishing these tables, it was said: "Comparative statements of this kind cannot fail to bring out some interesting points, and they may perhaps do the further service of impressing upon those in authority how desirable it is to have a uniform system of estimating and stating locomotive performance."

During the latter part of the period—now nearly three years—that those returns have been published, we have had serious doubts whether they were accomplishing what it was hoped they would when they were first announced, and whether they were of any considerable value to those for whose benefit they were especially intended. As they occupied, each month, a whole page of our space, which could be devoted to other interesting matter of which there is always a surplus, and as tabular typography is considerably more expensive than ordinary reading matter, we have been led to consider whether the space given to these returns might not perhaps be more advantageously devoted to other subjects. With this object in view, a copy of the following circular letter was addressed to all the Master Mechanics and Superintendents of Motive Power who supply us with their reports:

Dear Sir: For several years past we have been publishing each month in tabular form the locomotive returns of some 33 railroads. As there is considerable extra expense attending this publication, and as we get very little indication that our readers are interested in these returns, I have been led to write to some of the locomotive superintendents to inquire whether these returns, as published in The American Engineer, are of any value to them. If not, we could devote the space to other and perhaps more interesting matter, of which there is always an abundant supply. I would be much obliged if you would give your opinion frankly with reference to the advisability of the continuance of the publication of these returns.

In response to this 20 replies were received, in seven of which the writers said that they considered the returns as published in these tables were interesting and valuable, and expressed the hope that they would be continued. Thirteen of the writers thought the returns were of comparatively little value or interest. The following extracts from the letters will give a good idea of their tenor:

"It is, to my mind, questionable whether these returns as here given are of any real value. Each road works out its performance sheet and gets its percentages and averages independently, and there is no accepted standard to which to refer. To illustrate: on our road every shop expense for new tools, renewals, extraordinary expenses of all kinds are charged to supervision account, and divided *pro rata* among the regular accounts for the month, increasing them just that much. With my old friend Mr. ——, of the —— Railroad, however, the tool account is kept separately, and charged off to profit and loss at headquarters at the end of the year. Again, with us the oil and waste used by wipers is a factor in the 'Cleaning and Watching Account,' prorated according to the mileage among all the engines, while on the —— each engine is charged with the oil and waste used on it by the wipers, which goes thus to swell the oil account. Under circumstances of which the above are samples it is hard to make any comparison from these tables, or at least comparisons of any great value. Still, however, I should be very sorry to see this table done away with, as it gives me a slight idea at least of what the outside world is doing."

"I consider these reports of great value, and I believe that they are quite generally read. I would dislike very much to see them discontinued.

"I have at times taken a very great interest in a comparison between our own and the returns of other roads, and when such comparison was unfavorable, it was a stimulant to us to try and do better: and when the showing was better than other roads, it was very gratifying for us to have this information. If the matter were left to me as to whether or not this statement should be left out, I should say, leave it by all means.

"I never fail to look over these returns myself, and take considerable interest in them. I only wish the figures on other roads were given for cost on car mileage, which would make them of much more material value.

"I have looked for it each month for the purpose of making comparisons, and, by the way, have felt somewhat gratified at the showing of —— in number of tons of coal burned per train-mile, as compared with some of our Eastern friends, in view of the fact that we have heavy mountain grades on all three of our main lines. So far as I am personally concerned, I really think the publication of these statements is of great interest.

"For myself, I carefully look over that statement each month in order to see how our expenses compare with other railroads, and as far as I am individually concerned, I would be glad to see the publication of the statement continued."

"To me the returns have always been one of the points of interest in your paper. I only wish the table was more complete, showing all the large railroads in the United States, and I further wish that the performance sheets were all based on a given unit of work, and the grades and curvature of the different roads reduced to an equivalent of straight and level track, so that the report would be more intelligible and more useful than at present; but even as it stands, I do not know of any more interesting information than you could put on the page now occupied by this table."

"I have taken considerable interest in watching the locomotive returns which you publish, but it is a difficult matter to obtain any definite information on this point that would be comparative, as the circumstances vary so.

"It would seem to me until the locomotive reports are all made on the same basis all over the country, you cannot get an intelligent idea of the cost of locomotive performance.

"Personally I should prefer to have it omitted, substituting therefor other good reading matter, with which your journal is replete.

"The conditions are so different on different lines of railroad in the United States, one getting its coal at a very low price, and another at a high price, one getting its labor at a less rate than another, and so on, that it does not seem to me there is really a large interest taken in such returns, and the space could be used to better advantage.

"I am of the opinion that the space thus occupied might be devoted to more valuable matter, and I believe would be of much more interest to the readers.

"The more we have tried to use them for purposes of comparison between our practice and that of other roads, the more we have been confronted with the fact that different roads make up these returns in different ways; that it is almost impossible to get them down to any uniform basis, and that on that account these comparative performance statistics are almost sure to be misleading. Since we reached that conclusion we have not, ourselves, placed as much dependence on the figures published in your paper as we had previously

done. Therefore, our vote would be that, everything considered, it would not pay you to further continue the publication of these returns."

"I do not believe these returns are of any interest to your readers outside of those connected with the roads reporting, and while it affords me a basis of comparison, and is to this extent interesting, it would be rather selfish on my part to urge their continuance, if, as you say, the publication is attended with extra expense, and, no doubt, the space could be devoted to a matter of more general interest. I think, therefore, you would be justified in their discontinuance."

"There is such a wide difference on various roads in the method of keeping motive power accounts, also such a wide difference in the conditions of service, class of equipment, etc., on different lines, that, in my opinion, so long as these variations exist, it is not practicable to make reliable comparison between the performance on different roads in the country. The information on this subject that you have published in your paper is interesting to look over, and for the purpose of comparing the performance on one line of road from month to month; but as a comparison with different roads, I do not consider the reports reliable for reasons previously explained."

"We exchange performance sheets with all of the leading roads in the country, and I presume most of the other roads are doing the same; consequently the publishing of these sheets in The American Engineer is of little interest to us."

"I don't think that there is much interest taken in the locomotive returns referred to. They are not practical, as the systems of calculating mileage of switch and other engines are not uniform, and for other reasons I would cut them out for more interesting matter."

"At first I took considerable interest in the statements in tabular form of locomotive returns from some 33 railroads published in your paper monthly, but as the system of keeping accounts is entirely different on the different railroads, the results shown in your paper are not comparable. For instance, on the —— the salaries of the Master Mechanic and his force are charged to the expenses, and not shown under repairs of locomotives and cars. Under our system the salaries of the Master Mechanic's force and a portion of salaries of the Superintendent of Motive Power and his force are charged up to the repairs of locomotives. It would seem to me, therefore, advisable to drop this statement from your paper."

"I don't think the publishing of the monthly returns of locomotive performance sheets amounts to anything. I never look at them, and don't pay any attention to them. We do this because we feel well satisfied that there is nothing comparable about them. It is well known that even on a series of divisions of a large railroad such comparisons are eminently unfair. Take, for instance, on the ——, the —— Division will always show better results per mile run than any other division of the system, and this regardless of whether there is a first-class man in the Master Mechanic's chair or a very indifferent man. The good results obtained on the —— Division are due entirely to the natural physical condition of the road, and it is folly for any other road in the system to compete with it. We could make the same criticism in regard to the divisions of the——. I think the fairest and most interesting way to show what a railroad company is doing is to publish its performance for a term of years and then to make, or to require explanations to be made, explaining why the decreases occur or why the increases occur."

This testimony has led us to conclude to discontinue the publication of the returns. We shall, however, return to the subject again, and may endeavor to point out how a system of keeping locomotive returns might be devised which would make them comparable.

NEW PUBLICATIONS.

The Pocket List of Railroad Officials. Containing the Names of Officials in Charge of Railroads, Private Car Companies, Fast Freight Lines and Transportation Companies of the United States, Canada and Mexico. Also Showing the Gauge of each Road, Number of Miles Operated, and Rolling Stock in Service of each Company. New York: Published quarterly by the Railway Equipment & Publication Company, 326 Pearl Street. 292 pp., 4 × 6 in.

Most persons whose business brings them into relations with railroad officials have felt the need of some convenient directory of the names, addresses, etc., of such persons which may be conveniently carried about. Such a volume is provided by the "Pocket List" before us.

Besides the usual list of officers for each road, which is given in similar guides, this contains a table showing miles operated, gauge and rolling-stock equipment of the railroads and private-car lines, which is a new feature.

An alphabetical list of officials is also given, in which their names, titles and the record number of the railroad with which the official is connected. This record number precedes the name of the road in the regular list of roads, which are arranged alphabetically. It is, therefore, easy to refer to the number, which gives the name of the road.

There is also a list of places which are the headquarters of railroad officials. These are arranged alphabetically under the name of each State, the latter being also arranged alphabetically.

A list is also given of the names and location of the national and State railroad commissioners, including Canada. The names of the officials of each road, when there are several officers, are classified and their names placed alphabetically, which facilitates the finding of the name of a person desired.

The list is a very complete and convenient one, and is quite sure to be popular, especially among those whose duties lead them to travel to and fro in the land seeking whom they can sell supplies to.

The only feature about the book that seems to require criticism is its binding. This is done with wire, and so securely that it is difficult to open the book so as to be able to see the inner portions of the page, which is exasperating. The publishers ought either to improve the binding or furnish a small "jimmy" to each of its readers, to enable them to pry it open. If it is to be used as a travelling companion the covers should also be made of some more substantial material than stout paper.

Theoretical and Practical Ammonia Refrigeration. A Work of Reference for Engineers and Others Employed in the Management of Ice and Refrigeration Machinery. By Iltyd I. Redwood. New York: Spon & Chamberlain. 146 pp., 4¼ × 6¼ in.; $1.00.

"Freezing machines," the author of this little book says, "are now coming so generally into use in large factories and manufacturing establishments where natural ice was formerly employed, that they are of necessity placed, directly or indirectly, under the supervision of men who, owing to the comparative newness of the subject of ammonia refrigeration in relation to the manufacturers, cannot be expected to be thoroughly conversant with their theoretical and practical working.

"It is with a view to giving those connected with the running of ammonia refrigerating plants a more intelligent idea of what they are doing that this book has been written."

With this object in view the author begins with explanations of some of the elementary principles and terms which relate to the science and art of refrigeration. The second chapter is on the theory of refrigeration by compressed air and ammonia, and in it the characteristics of ammonia are described. Chapter III contains a description and engravings of a refrigerating plant, both of which it is thought might have been more full and complete with advantage to the reader. In the fifth chapter various appliances used in connection with refrigerating plants are described, and in the remaining chapters contain explanations and directions for the management of refrigerating plants. A good index completes the book, which will doubtless be very acceptable to large numbers of people who are concerned in the management and use of the class of machinery to which it relates.

The Memphis Bridge. A Report to George H. Nettleton, President of the Kansas City & Memphis Railway & Bridge Company, by George S. Morison, Chief Engineer of the

Memphis Bridge. New York: John Wiley & Sons. 74 pp. of text, 60 plates and 6 full-page photographic views of the bridge during erection and on completion. Size of pages, 13¾ × 22 in.; $10.00.

The report before us forms one of a number of magnificent albums which Mr. Morison, now the President of the American Society of Civil Engineers, has published, and in which he has described the different bridges of which he has been the chief engineer. The report is prefaced with a large engraving made from a photograph showing the bridge as it appears on completion. The report itself contains: I, A Preliminary Narrative, giving an account of the origin and history of the bridge, and the legislation and corporate action which led to its construction; II, A General Description; III, A Detailed Description of the Substructure, in which each pier is described separately; IV, A Description of the Superstructure, Material, Contracts and Contractors, Erection and Weights of Superstructure; V, A Description of the West Approach Viaduct; VI, The Approaches; VII, The Shore Protection; VIII, The Cost; and lastly Appendices, giving a list of the names of engineers, employés and contractors; acts of Congress; contract with the War Department; reports of February 15, 1887, and August 2, 1888; argument for the amendment of charter; local ordinances; tables giving the time, cost and materials used in foundations; other tables giving the records of the sinking of the caissons; specifications for masonry and superstructure; descriptive tables of tests of steel eye bars, and report of Testing Committee.

Besides the view of the completed bridge, there are six views showing the process of sinking the mattress of pier II; a large view showing the east portal of the bridge; another of the traveller used on the east end; other views showing the east intermediate span during erection; the west approach.

The sixty lithographed plates consist of, first, two excellent maps showing the location of the bridge; a profile showing its vertical alignment; a general elevation and plan; a profile showing the stratification below the river on the bridge line; two diagrams indicating the height of water during 1886–92; graphical records of soundings of the river and views of the east abutment. This is followed by 19 plates showing the construction of the caissons and piers and the appliances used in putting them down. Twenty-eight sheets represent the superstructure, and a number more relate to the approaches. All of these are admirably drawn, and show the whole structure in great detail and in the most complete manner. The report, like all that Mr. Morison has issued, is a model of its kind and is one which will be a work of reference for all time, or as long as wood-pulp paper will last.

Les Reformes des Tarifs des Voyageurs. By L. de Perl. Paris: J. Rothschild. 279 pp., 6 × 9 in.

The reformation of passenger tariffs, in regard to which this work is especially directed, refers more particularly to a careful investigation of the results obtained in the working of the Hungarian zone system. In fact, the Russian Minister of Finance, who appointed M. de Perl to make the report of which this book is the embodiment, merely contemplated at first an investigation of the change in passenger tariffs that has been adopted by the Hungarian government, with the view of determining whether or no it could be applied to Russian railways. After setting about this work, it soon became evident to the author that an investigation of the general conditions controlling passenger tariffs throughout the several countries of Europe would be required. This was done, though the author does not lose sight of the fact that the Hungarian zone tariff is to occupy the principal position in his report. In reading the book one has the feeling that it is written by a man who has made a thorough and careful study of the subject, but who is not altogether familiar with it from the standpoint of a man who has had to do with the adjustment of rates in actual practice. This does not imply by any means that the conclusions reached by the author are not worthy of the highest consideration. He gives a rapid review of the conditions of passenger rates in nearly all the countries of the world; compares and checks off the privileges accruing to purchasers of different classes of tickets. As an example of his method of working, we give the headings of the paragraphs of the chapter devoted to the United States: Rates in Operation on the Railroads of the United States; Commutation Tickets; Mileage Tickets; Baggage. After a careful review of the work done and the results accomplished by the Hungarian zone tariff, the author comes to the following conclusions:

1. Minister Baross, independently of his politico-economical objects, has hit upon a happy means of adding to a traffic that seemed to have touched its highest notch, proving that even in a sparsely populated country it is possible to develop a traffic that it would naturally seem impossible to increase.

2. The principal object for which the zone system was introduced—namely, that of increasing long-distance travel—has, in fact, not been accomplished; not only has the average distance travelled per passenger not increased, but it has actually fallen off from 36.6 miles to 25.5 miles. Although the distance travelled by passengers on express trains has risen from 48.5 miles to 63¾ miles, it must be remembered that the number of passengers carried on these trains amounts to only 5 per cent. of the whole, and that the increase in the number of long-distance travellers has been obtained by making better connections with other lines.

3. By abolishing the third class on express trains, passengers who usually travelled at this rate were driven into the second class.

4. Not only has the hope of seeing passengers from the lower classes take the higher not been realized, but, on the other hand, the number of third-class passengers has actually increased, to the detriment of passengers of the two upper classes.

5. The improvement in the loading of cars, which was estimated at 10 per cent., has not been realized on account of the limited number of cars in the trains, as well as by the crowding of passengers in the cars. Even though they might increase the number of trains and the number of cars in a train, the utilization of the places could hardly be improved more than 5 per cent.

6. The increased value of the movement of passengers, where the traffic is about up to its limit in the central zone, is to a great extent absorbed by the few passengers going between zones II and XII. As for the hope of maintaining or increasing the travel and receipts in zones XIII and XIV in the future, it is very doubtful whether it can be done. It is difficult to suppose that the tendency of the Hungarians to visit the capital will keep up to the present standard in the future, when the first influence of the reduction of rates is not felt. For tourists and the general traveller this city has no attractions which the other European capitals do not possess.

7. The doing away with the free transportation of a certain amount of baggage has not exercised, in spite of the increased traffic, the favorable results on the receipts of this department that were expected, while the cars are encumbered with the great quantities of luggage, that passengers persist in carrying in their hands.

8. The net benefit of the system adopted by the managers of the Hungarian State railways is not such as to lead one to believe in the utility of the zone system of tariffs. And one can assert with certainty that the increase in receipts obtained from an increase in the traffic near the capital is insufficient to cover the loss in receipts in the more distant zones; that the cost per passenger will exceed the receipts, and that the adoption of the zone system will always result in loss.

Practical Application of the Indicator with Reference to the Adjustment of Valve-gear in all Styles of Engines. By Lewis M. Ellison. Published by the Author, 25 West Lake Street, Chicago. 197 pp., 6 × 9 in. $2.

In his preface the author of this book says that in the practice of his occupation—that of a consulting engineer—he found many engineers (that is, men who run engines) who have expressed a desire to learn the use of the indicator. In recommending various books to such persons he found that there was a very general complaint that they were not sufficiently *definite* (probably *lucid* is what is meant) for the beginner. This experience, and the fact that he himself has felt the need of more practical information on the subject, led him to the effort to produce a "work which will meet the requirements of the beginner as well as the experienced engineer," which was certainly an excellent motive. Of his qualifications for carrying out such an undertaking his book must testify. There is abundant evidence all through it that the writer possessed the knowledge and experience needed for his task; but something more than this is needed to write such a book as he aimed to produce. To quote again the words of Huxley, which perhaps cannot be repeated too often: "Good exposition implies much constructive imagination. A prerequisite is the forming of true ideas of the mental states of those who are to be taught; and a further prerequisite is the imagining of methods by which, beginning with conceptions they possess, there may be built up in their minds the conceptions they do not possess." The distinguished author says further: "Of constructive imagination as displayed in this sphere, men at large appear to be almost devoid." It is in this direction and not in a knowledge of his subject that the author seems to be deficient. If, as he says, his aim was to "produce a work

which will meet the requirements of the beginner" who desired to learn the use of an indicator, it would seem as though an absolutely essential feature would be to explain with the greatest clearness and fulness the purpose for which indicators are used, and their construction and operation. It is of the utmost importance that a beginner should know how an indicator is made and what it is for. Now the only description of it in the book is one consisting of fifteen lines at the beginning of the first chapter. There is no illustration of the instrument accompanying it, and it is, and any other description would be, unintelligible to a beginner without an engraving of some kind. The understandableness—to coin a word—of any description, too, will depend very much upon the fulness and clearness of the engraving of it. In this respect the author has certainly been lacking in "constructive imagination."

In explaining the practical application of the indicator he describes, among other appliances, the pantograph; but he would be a very bright person indeed who, without any other knowledge, could comprehend from the meagre description and the illustration how this is applied to the indicator, and what it is intended to do when it is so applied. There is no clear description, either, of the action of the steam in the cylinder, which a beginner could easily understand, nor an explanation of how the indicator shows this action. Of observations relating to its actual use the book is full. Thus, after the brief description referred to, without a break even into separate paragraphs, the reader is told, "Before using the indicator, clean the bearing surfaces of the cylinder and piston, and lubricate them with the best cylinder oil that is clean and does not stick or gum," which is important and useful instruction, but it cannot take the place of some clear comprehension of what an indicator is and is intended for. The book is full of information with reference to what may be called the manipulation of the indicator, which is excellent in its way, but it leaves the reader in a fog about the principles of the subjects which are being explained. Thus, on page 39 it is said: "The amount of cushion per square inch on the piston depends principally on the weight of these parts and the speed of the engine; and no more cushion should be given than is required to accomplish this result, as a greater amount has the same defect as too early admission." Now, after reading this, almost any intelligent person would have an insatiable desire to ask *how much* cushion "is required," which is not explained.

Chapter IV is on Diagram Analysis; V, on Cushion; VI, on Setting Corliss Valves with the Indicator; VII, on Diagram from Steam Pipe; VIII, on Setting Automatic Riding Cut-off Valves with the Indicator; IX, on Setting Single Valve Automatics with the Indicator. Succeeding chapters are on Boiler Feed Pump Diagrams; Calculating the Mean Effective Pressure by Ordinates; The Planimeter; Computing the I.H.P. of an Engine; Testing the Piston and Valve for Leaks; Locating the Theoretical Curve; Steam Tables and an Analysis of Diagram from an Ammonia Compressor.

All these chapters are brimful of practical suggestions, the residuum, as it were, of the experience of the writer, and which will be very profitable reading to any one seeking information on this subject. In another respect, too, the book may be highly commended—that is, by the absence of mathematical gymnastics. The author has given the results of his observation and experience in a very plain, matter-of-fact way. He gives in great fulness examples of indicator cards which "indicate" various defects and organic diseases, and tells the reader how to make his diagnosis and what remedy to apply. The author has not attempted to show how much mathematical knowledge he was the proud possessor of, for which credit is due to him. It is true that he now and then has a fling at "so-called" experts, which is suggestive; but his book tells us very clearly and simply what he has evidently learned by observation and has been confirmed by experience.

BOOKS RECEIVED.

TRANSACTIONS OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Vol. XV. 1,359 pp., 6 × 9 in.

POPULAR SCIENTIFIC LECTURES. By Ernest Meech. Chicago: The Open Court Publishing Company. 313 pp., 5 × 7½ in.

EIGHTH ANNUAL REPORT OF THE INTERSTATE COMMERCE COMMISSION. Washington: Government Printing Office. 271 pp., 5¾ × 9 in.

PROCEEDINGS OF THE U. S. NAVAL INSTITUTE. Vol. XX. No. 4. Published quarterly by the Institute, Annapolis, Md. 206 pp., 5¾ × 9¼ in.

STREET RAILWAY INVESTMENTS. A Study in Values. By Edward E. Higgins. New York: Street Railway Publishing Company. 102 pp., 5¾ × 9 in.

JOURNAL OF THE AMERICAN SOCIETY OF NAVAL ENGINEERS. Vol. VII. No. 1, Feburary, 1895. Published quarterly by the Society, Washington, D. C. 214 pp., 5¾ × 9¼ in.

ADMINISTRATION REPORT ON THE RAILWAYS IN INDIA FOR 1893-94. By Lieutenant-Colonel T. Gracey, R.E., Officiating Director-General of Railways, Calcutta. India: Office of the Superintendent of Government Printing. 453 pp., 8½ × 13 in., with map of Indian railways.

TRADE CATALOGUES.

IN 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. The advantages of conforming to these sizes have been recognized, not only by railroad men, but outside of railroad circles, and many engineers make a practice of immediately consigning to the waste-basket all catalogues that do not come within a very narrow margin of these standard sizes. They are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

STANDARDS:

For postal-card circulars.............	3½ in. × 6¼ in.
Pamphlets and trade catalogues.......	3½ in. × 6 in. 6 in. × 9 in. 9 in. × 12 in.
Specifications and letter paper........	8½ in. × 10¾ in.

MARKS' PATENT ARTIFICIAL LIMBS WITH RUBBER HANDS AND FEET. A. A. Marks, New York. 33 pp., 3½ × 8¾ in.

This is not a cheerful publication to review. It is all about artificial limbs, amputations, etc., and all that need be said is that those unfortunates who need the information which it is intended to give can obtain a copy from the publisher, whose address is 701 Broadway.

THE LODGE & SHIPLEY MACHINE TOOL COMPANY. Machine Tools for the Rapid Production of Lathe Work. Cincinnati, O. 24 pp., 3½ × 6¼ in.

A very good wood-engraving of one of this company's lathes forms the frontispiece of this catalogue and is the type of a number of different sizes which are fully described in the rest of the pamphlet.

LUKENS IRON & STEEL COMPANY, Coatesville, Pa. 62 pp., 4½ × 7 in.

The Lukens Company make boiler plates, and incidentally thereto they also flange boiler heads and flue and manholes, supply manhole covers of a design of their own, and also make the Huston boiler brace, which is formed out of strips of steel, bent so as to form the feet and increase the strength of the brace itself. A number of tables and a telegraphic code completes the book.

BRASS PIPE FOR PLUMBING. By the American Tube Works, Boston. 68 pp., 3¾ × 5¾ in.

The purpose of this pamphlet is to describe the pipe made by this company and point out its uses and advantages. Certificates from plumbers and others are given, showing the superiority of this kind of tubing so attractively that after looking through it one is inclined to rip out all the old pipes in his house and put in new ones—a result which, no doubt, the American Tube Works would like to have accomplished.

THE DAYTON RAILWAY CROSSING GATE, for the Protection of Street Crossings. Manufactured by the Craig-Reynolds Foundry Company, Dayton, O. 20 pp., 5 × 6¾ in.

Some six months or more ago this company issued a catalogue which was noticed in our issue of last June. We then poked a little fun at the company on account of some poetry which was published in their catalogue. In the edition before us the effusion which was the occasion of our pleasantry is omitted. The gates which the company makes are very well illustrated and clearly described, although we wonder why the engravings were not made so as to occupy more of the pages on which they are printed. If made to a larger scale they would have been much more effective than they now are. The frontispiece is a good view of the works from a wash drawing,

and the "finis" is an admirable little engraving representing an angel in conjunction with a Dayton railway gate protecting a crossing.

THE PNEUMATIC POWER AND MOTOR COMPANY, OF NEW YORK. 18 pp., 6 × 9 in.

This pamphlet is the prospectus of a scheme for using "pneumatic" power for propelling vehicles on "steam, street, or elevated railroads." What is proposed is the use of a tube, or, rather, a continuous cylinder laid in a conduit between and below the rails. In this a piston or pistons move which are to be connected by some kind of attachment or "grip" to the vehicles, and is similar to that which was tried on a road in Ireland between Kingstown and Dalkey in the forties, and which is illustrated and described in the early books on railroads. The authors give us very little description of their proposed system, but elaborate calculations of its economy. Whether compressed air is to be forced into the cylinders or the air exhausted from them we cannot find out from the pamphlet before us. At a very prominent place, though, it is said that "the capital stock is divided into 500,000 shares of the par value of $10 each, full paid and non-assessable." Readers who don't want to miss the chance of subscribing had better hasten to the office of the company, which is at 55 Dey Street, New York.

ILLUSTRATED CATALOGUE AND PRICE-LIST OF PUMPS AND HYDRAULIC MACHINERY FOR EVERY SERVICE. Pump, Supplies, Well Tools, etc. Manufactured by the Goulds Manufacturing Company, Seneca Falls, N. Y. 356 pp., 7 × 8 in.

The Goulds Manufacturing Company make pumps for domestic, industrial, and manufacturing purposes, and in the catalogue before us only hand pumps and those operated by power, belting, gearing or electricity are described. No steam pumps—that is, those in which the steam pressure in a steam cylinder is applied directly through a piston-rod to a hydraulic cylinder, are shown. As some hundreds of different kinds of pumps are illustrated, obviously only a passing reference can be made to the classes in which they are included. These include pumps for domestic purposes, irrigation, centrifugal, and power pumps of various kinds; boiler feed pumps, spray pumps, garden and fire engines, hydraulic rams and hydrants, and a miscellaneous assortment of supplies, such as pipes, cocks, pipe fittings, etc.

In going through the book and seeing the great variety and extent of the business of pump-making, one is impressed with the idea that if the Goulds Manufacturing Company had existed in Noah's time that the deluge might not have happened, as this company could perhaps have pumped it dry.

The mechanical execution of the book is excellent, and besides the mere matter pertaining to a catalogue there is considerable information scattered through it of a technical nature relating to pumps and hydraulic machinery. A good index at the front adds to a reader's confidence in the pages which follow.

CONCERNING MANNING BOILERS, with a Report upon the Performance of the Bigelow-Manning Boilers at the Bristol Manufacturing Company's Cotton Mills in New Bedford, Mass., made by J. E. Denton, Professor of Experimental Mechanics, Stevens Institute of Technology. The Bigelow Company, New Haven, Conn. 34 pp., 5¾ × 9 in.

The descriptive title of this pamphlet indicates its general purpose, which is to describe the Manning boiler and set forth its advantages. This is very well done, first by a description and next by some admirable wood-engravings, one showing a front view of a boiler partly in section, another a sectional plan and a section of the ash-pit. Other outline views show a plan front and end views of a battery of eight boilers of the Bristol Manufacturing Company, and also a perspective view of these boilers as they appear in the boiler-room made from a wash drawing. Professor Denton's report is full and complete and gives all the data likely to be looked for in such an investigation.

The Manning boiler is vertical and internally fired, with a cylindrical fire-box surrounded with water spaces. The fire box is of larger diameter than the barrel of the boiler, the latter being attached to the outer shell of the former by a double-flanged plate which permits of a limited amount of difference of expansion between the tubes and the shell. The upper ends of the tubes pass through the steam space for some distance, the effect of which is to superheat the steam somewhat. This form of boiler seems to be gaining in favor wherever used.

A CATALOGUE OF THE DEVICES AND THEIR PARTS MANUFACTURED BY THE UNION SWITCH & SIGNAL COMPANY, Swissvale, Pa. 351 pp., 9 × 12 in.

The magnificent volume before us, which has just been issued by the Union Switch & Signal Company, is essentially a catalogue, and only to a very limited extent a treatise descriptive of the science and art of signalling. Under separate heads it treats of the Saxby & Farmer Improved Interlocking Machine; the Electro-Pneumatic Interlocking Machine; Electro-Pneumatic Automatic Block Signalling; the Union Electric Banner, Target and Disk Signals, and the "Union" Lock and Block System.

Most of the illustrations in the book are half-tone engravings made from photographs. A general view is usually given of the mechanism illustrated, and the separate details of the various parts are then represented. These were assembled or grouped, and each group occupies a page, or, in some cases, a part of a page, which is designated by a "plate" number. The plate and piece number being given thus indicates precisely what is referred to. Accompanying the different plates is a list of the parts represented, giving their numbers, names and, in some cases, explanatory or descriptive matter in addition. Thus, plates 1 and 2 represent front and back views of the Saxby & Farmer interlocking machine, the engravings of which were made from photographs. Following this are plates 3 and 5, in which the different parts are represented separately, each being numbered. In an introduction, and at the head of each list, parties are instructed to order "by plate and number." In this way there is never any difficulty in designating exactly what is wanted.

Interspersed through the book are excellent full-page views of track and signals at different places which have been erected by the Union Switch & Signal Company. Among them are views taken at Detroit; the Grand Central Station, New York; Broad Street Station of the Pennsylvania Railroad in Philadelphia; on the Michigan Central Station, Detroit; Union Station, Chicago; five views of the Jersey City terminal of the Pennsylvania Railroad; the Newark Bay Drawbridge on the Central Railroad of New Jersey; and the train shed of the Philadelphia & Reading Railroad, in Philadelphia. Plans of most of these terminals are also given, showing the arrangement of tracks and the disposition of signals. The only criticism of these views which we find room for is that it would have been somewhat more convenient to the reader if the title of the engraving had been placed below the engraving instead of on the opposite page at right angles to the view. This observation does not, however, apply to the maps or plans of the tracks.

A table of contents at the beginning and an excellent alphabetical index at the end complete this admirable volume. The paper and typography are excellent, and the volume sent to us is luxuriously bound in flexible morocco covers with the name of the editor of this paper imprinted in becomingly modest gilt letters on the cover. The only suggestion for the improvement of this admirable catalogue which can be made is the observation that if, before the different parts were photographed, they had been painted with a dead coat of lead-colored paint the photographs and engravings would have been more effective. Without such a coat of paint not only do the defects in castings show, but they are often exaggerated, as on Plate 26, and all the local color, rust, grease stains, etc., show. All of these, excepting, perhaps, bad defects in castings, are obliterated by the paint, and the forms are brought out much more distinctly by the uniform tint of the surface.

THE PELTON WATER-WHEEL; EMBRACING IN ITS VARIATIONS OF CONSTRUCTION AND APPLICATION THE PELTON SYSTEM OF POWER. Manufactured by the Pelton Water-Wheel Company, San Francisco, Cal., and 143 Liberty Street, New York. 100 pp., 7 × 10½ in.

In an appendix to this catalogue the publishers say: "The literature pertaining to modern hydraulic methods, as embraced in the Pelton system, it is well known, is very meagre and only accessible through mining reports and trade journals, hence cannot be readily availed of by the general mining and engineering public."

Recognizing this fact, the publishers of the book before us say that they have endeavored to collect such information and present it in a form which would make it readily available by those interested in the subject. This has been very effectively done. The book begins with some general observations on the use of water-power, and then goes on to describe the construction and operation of Pelton water-wheels, of which some excellent wood-cuts and outline engravings are given. Various forms and applications of these wheels are described and illustrated. They are shown as arranged for driving dynamos,

blowers, pumps, hoists, air compressors, inclined railway at Mount Lowe, for the electric transmission of power, etc.

A great deal of information is given with reference to estimates for water power, size, capacity and weight of wheels, H.P. of water. A very interesting portion is that relating to the use of wrought-iron riveted hydraulic pipe, which has been used so extensively and successfully on the Pacific Coast for conducting water from its sources of supply to places where its power was to be utilized. Elaborate tables giving the price, weight, loss of head in pipe from friction, etc., are given. Much other information of very great interest to all concerned in this method of generating power is contained in this interesting book, but to which there is not room to refer. It is, however, deserving of the highest commendation in every respect. Printing, paper, engraving, and typography are all excellent.

Illustrated Catalogue and General Description of Improved Machine Tools for Working Metal. Designed and Constructed by William Sellers & Co., Incorporated. Philadelphia. 439 pp., 7½ × 7½ in.

We are acquainted with a reflective person who, at times, when the complexity of modern life forces itself upon his attention, makes the observation that if, through any great cataclysm of nature, we should be buried as ancient Herculaneum and Pompeii were, and if some thousands of years thereafter our remains should be dug up, "what a d——l of a time the archæologists will have to tell what all the appliances of the present day were intended for." Doubtless our friend would repeat his observation if he should go through the new catalogue which has just been issued by William Sellers & Co. It is illustrated by 243 engravings, showing a variety of machinery for working and handling metal, a list of which would exceed the limits which we can here give to it, and its variety and intricacy would deter even an expert in this branch of mechanical engineering from attempting to understand the purposes, uses, and adaptations of all the machines which are illustrated therein unless a liberal amount of time was allowed him for the task. If in the year 4995 a copy of this book should be dug up from under the ruins of, say, the City Hall of Philadelphia, the archæological society of the "coming race" will doubtless hold special meetings and listen to tedious papers—as we do now—to show what the appliances which are illustrated therein were intended for; and when they learn further what that hall cost, and read of the corruption of the ruling classes in our cities of to-day, they may conclude that the ponderous shearing machines illustrated on pages 226 and 227 were intended to behead politicians, and the travelling cranes for hanging them by wholesale, and the steam hammers for crushing them expeditiously out of existence, and thus reducing them to a condition which would be without form and void. This analogy might be carried still farther, but it would only lead to the reflection that we can now see no reason why our descendants should need any better machine tools than William Sellers & Co. make, and to entertaining the hope that in a few thousand years they will have improved on our political methods and practices.

As the book is somewhat novel in its form and design, and the engravings were made by a method not generally adopted, a little description, which is quoted from a letter received from the compiler of the book, will be of interest:

"As the proposed book," he says, "was not to be made for sale or to ornament the shelves of a library, but for purely business purposes, to be handed about and perhaps studied by two or more persons at the same time, two radical departures from usual custom were proposed and adopted; one related to the shape of the book, whereby all the illustrations of horizontal and upright tools appear in the same position as the type matter. The other point of departure was to have the plates made *as large as the page permitted*. As the book was to be a pictorial record of machines made in the past, as well as those of most recent construction, requiring more than two hundred new plates, the 'half tone' process commended itself. Samples of work were prepared by a number of bidders, but they all showed a lack of strength and sharpness of detail as compared with wood-cuts, and experiments were made to more nearly approximate the vigor of engravings or wood-cuts while retaining the photographic fidelity of the half-tone process. The method adopted was tedious and somewhat costly. A faint platinum print—usually an enlargement—was made on plain paper. This was used as a 'groundwork' for a free-hand artist, working in sepia or india ink with brush, crayon and pen. The artist's 'subject' was then examined by a mechanical draftsman, and corrections, if any were needed, were made.

"The usual half-tone negative was taken from this prepared subject, in which all of the important features had been strongly emphasized, and finally a certain amount of engraving was done upon the copper plates and the backgrounds routed out. This latter feature was quickly appreciated, and has become, since our work began two years ago, a common feature in such plates."

This method undoubtedly has the result of bringing out distinctly the details of the different machines, the vagueness of which is often a defect of half-tone work, and no doubt this method is much cheaper than wood-engraving. Photographs which are retouched in this way always have, however, more or less of exaggeration in the high lights and some details. Thus in most of the engravings in the book before us the flooring is grained "by hand," and in some of the illustrations this feature is so prominent that it strikes one first on looking at the illustration, and it is safe to say that no lumber ever grew with such a grain as is shown in some of the illustrations. From a purely artistic point of view the illustrations can hardly be approved, but they show the machines clearly, and that is their most important purpose.

The volume opens with an introduction about machine tools generally—the design of the catalogue—and an account of the awards made to William Sellers & Co. at different exhibitions, beginning with Vienna in 1873. A number of interior views of the works are given in this introduction, and the catalogue then opens with descriptions and illustrations of bolt and nut-screwing machines, of which four different types are illustrated and described. The engravings of the machines are printed on the right-hand page and the description opposite to it. This description is fuller than is ordinarily given in similar catalogues, and sets forth the peculiar advantages of the machines illustrated, their dimensions, and often a little dissertation on the class of machines described.

Under the head of Vertical Drill Presses seven types are shown and described. Eight other special drilling machines, including radial drills, are also illustrated. Thirty different types of boring machines, horizontal and vertical, are included under that head, and 25 different kinds of lathes in the following one. There is a strong temptation to quote the dissertation on lathes with which this section is prefaced. Generally it is an argument for the flat-top shear instead of the V shear.

Seven different examples of grinding machinery and a large number of examples of lathe, planer and miscellaneous tools, which have been finished on the tool-grinding machine, are illustrated. A cold saw for cutting rails, beams, etc., is also represented. This is followed by milling machines, of which six varieties are given. The following list of the additional machines illustrated will give an idea of the variety of the tools which are made by this company: Two rotary planers; 5 shaping machines; 4 slotters; 16 planing machines; 1 rifling machine; 20 punching and shearing machines; 6 steam hammers; 11 riveting machines, steam and hydraulic; a hydraulic accumulator and pump; straightening machines for shafts and beams; 11 plate-bending rolls; 7 hydraulic presses and screw machines; 4 hoisting machines; 13 jib cranes; 14 travelling cranes; a sand-mixing machine; 9 illustrations of turn-tables; 10 illustrations of "Emery" testing machines; 11 illustrations and a long article on shafting, with a considerable essay on that subject. Under the head Injectors there are 11 illustrations. Vicar's mechanical stoker is also illustrated and described. An excellent index, in which the reference words are printed in black-faced type, completes this admirable publication.

PHYSICAL REASONS FOR RAPID CORROSION OF STEEL BOILER TUBES.

In investigating the oft-repeated assertion that "boiler tubes made from steel corrode and become unserviceable much more rapidly than those made from charcoal iron," we have made the following experiments, as given below:

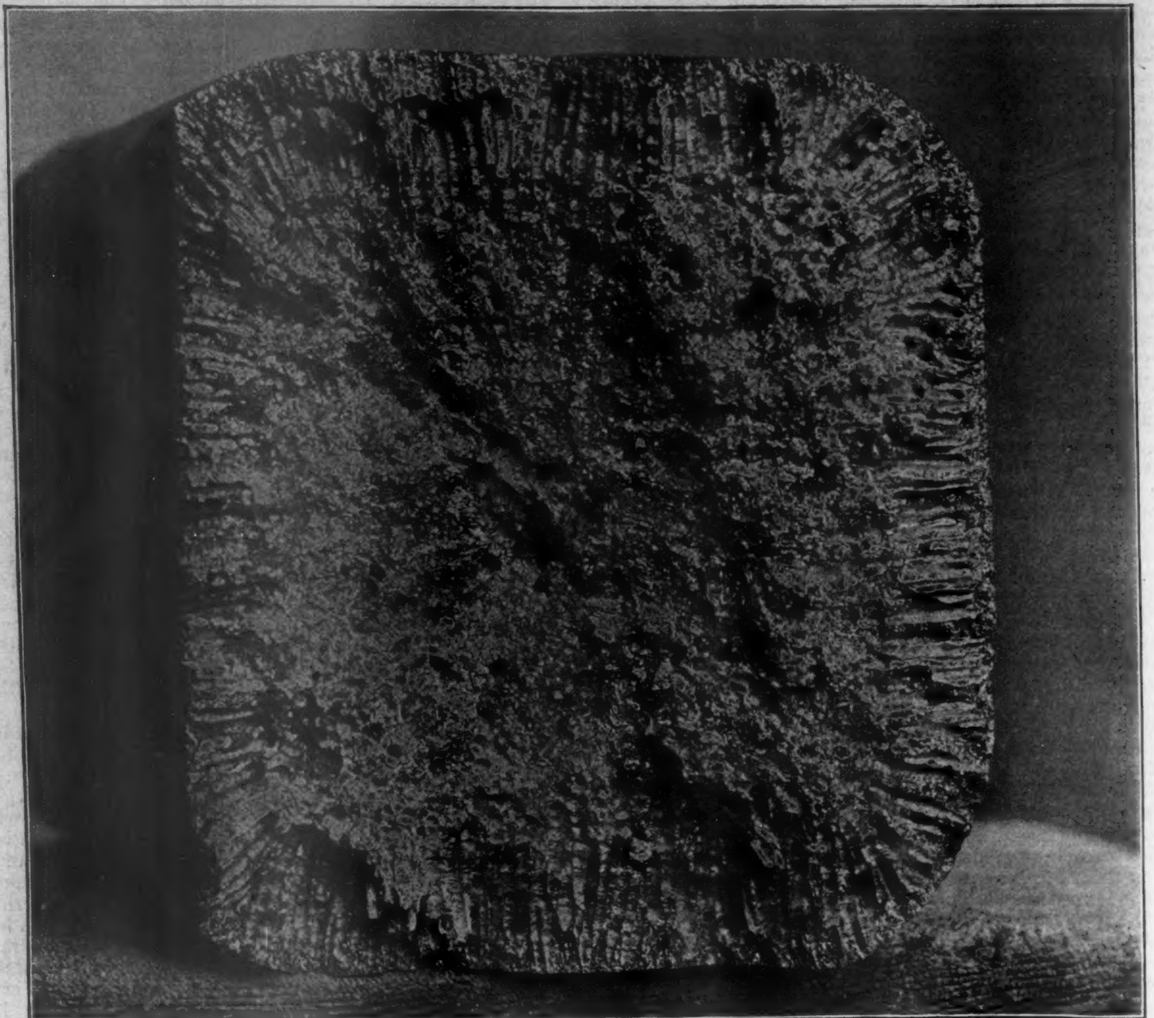
Taking a "heat" of ingots made of 7 in. × 7 in. × 4 in., weighing about 650 lbs. each, of the best open-hearth basic steel of following analysis: Carbon, .10; phosphorus, .014; manganese, .21; sulphur, .026; copper, .05, we first gave them a "wash heat" and cut them into two nearly equal pieces, then transferred them to heating furnaces again, and after another slight heating rolled them down direct to No. 9 gauge and sheared them into skelp for 4-in. tubes, being careful to keep separate the skelp made from tops and bottoms of ingots.

We found that the "bottoms" of the ingots invariably worked smooth and clean into plates and sheared with only a normal wastage, but that the "tops" were almost uncontrollable in rolling, working soft, spongy, and with much irregu-

larity, and the surface of the plates when finished had a muddy, dirty appearance, indicating an excessive amount of cinder. Allowing one of the "tops" of ingots to cool after the first wash heat, on close examination its whole surface was found to be closely covered with minute holes, so close together that in a diameter of 1 in. as many as 25 of these minute holes could be counted, into which in many instances a needle could be entered to the depth of from 1 in. to 1¼ in.

creased in size, but still present in great numbers in the "top" section, while the "bottom" was comparatively smooth and solid.

Each one of these compressed cells has walls of solid metal encasing infinitesimal shot of slag, which in the boiler tube in service, with the incessant expansion and contraction of greater or less heat, will finally open slightly, admitting a little dampness, which under the heated condition of action



FRACTURE OF OPEN-HEARTH STEEL INGOT. AREA, 6½ IN. × 6½ IN.

Number of Cells immediately under Surface exposed in Fracture, 253. Average Depth of Cell, 1¼ in. Average Diameter of Cell, ⅛ in. Analysis: Carbon, .10; Phosphorus, .014; Manganese, .21; Sulphur, .026; Copper, .05. A Physical Reason for the Corrosion of Steel Boiler Tubes.

Our next step was to nick and break with a heavy drop the upper or "top" of one of these ingots before heating, with the result that the fracture developed an almost entirely spongy or honeycombed structure, extending from ½ in. under the skin or surface to about 1½ in. in depth uniformly around the four sides of the ingot, and in many instances these cells ramified and extended to the centre. Actual count of these cells in face of fracture 6½ in. × 6½ in. was 253.

This spongy condition, no doubt, revealed the at first unaccounted-for difference in working between "top" and "bottom," as the same ingot when broken cold, half-way up, showed much less of the cellular structure, which, no doubt, almost entirely disappeared on a nearer approach to the bottom, owing to hydrostatic pressure of molten steel in the mould driving out the gases before solidification occurred.

Our next step was to have tubes made from "tops" and "bottoms," with a report as to the working of the two, which only went to confirm our earlier investigations, that the "tops" welded freely, and even blistered sometimes, while the "bottoms" worked hard and stubborn and were difficult to weld. Taking sections of these tubes made from the respective portions of ingot, they were put in a lathe, burnished, and subjected to microscopical examination, which revealed these same "cells" or "honeycomb" structures much de-

will undoubtedly set up very rapid corrosion and early disintegration of the whole tube.

Before we had the opportunity of making this thorough test we were at a loss to know why steel tubes made from finest obtainable open-hearth stock should show such short lives when compared with those made from *charcoal iron*, but this would seem to be ample confirmation, for the known fact that, as a rule, steel has been most disappointing in service when compared with the possibly less pure chemically, but more homogeneous and durable charcoal iron.

To make a free welding steel for boiler tubes, this sponginess *must* exist, and the more pronounced it is, the more thoroughly it will weld and the more rapidly it will corrode. Conversely, the more solid and free it is from "honeycomb" in the ingot, the more difficult, if not impossible, it is to weld, and the longer the *unwelded* life in the boiler.

It is a matter of record that the United States cruiser *Chicago* put new steel tubes into some of her boilers about two years ago, that were riddled with holes as large as shot inside of 40 days' service, while others of her boilers had the original charcoal iron tubes that were put in when they were built, and which were still good after service of some five years.

PARKESBURG IRON CO.,

Parkesburg, Pa. W. H. GIBBONS, *President.*

SOME FACTS RELATING TO CERTAIN TYPES OF WATER-TUBE BOILERS.*

In buying a boiler, it is just as necessary to know what *won't* do as what *will* do.

A certain set of elementary forms or units have been repeatedly used in the construction of sectional and water-tube boilers, and have by repeated failures demonstrated their unfitness for the service required.

The primary cause of their failure can be traced, in every instance, to the impossibility of removing the accumulation of scale that must result from the evaporation of water (despite the claims made by the inventors that the rapidity of the circulation in their particular design prevents the deposit of scale); and until some inventor succeeds in evaporating salts of lime into steam, failures of these particular forms must be expected.

Re-inventing a device, or disposing of a well-known unit in a slightly different position, retaining all its elementary defects, cannot alter the final results. Boilers come within the Darwinian law of "*the survival of the fittest*," as surely as does any form of animal life, and the reappearance of unsuccessful forms must be regarded as a freak, not of nature, but of inventors. It is time that some of these unsuccessful elements should be specified, and as it would be impossible to chronicle all the deaths and resurrections that have occurred among these unfortunate families, we have selected typical cases, emphasized by the prominence they have attained at their first appearance, or subsequent prominence in engineering circles, due to their repeated failures.

UNIT NO. 1.

Closed-End Tube.

RADIAL WATER TUBES WITH ONE END CLOSED, THE OTHER END HAVING FREE CONNECTION WITH A WATER RESERVOIR.

John Cox Stevens, an American engineer, was the first inventor of this unit, using it in the boiler (fig. 1) of a small

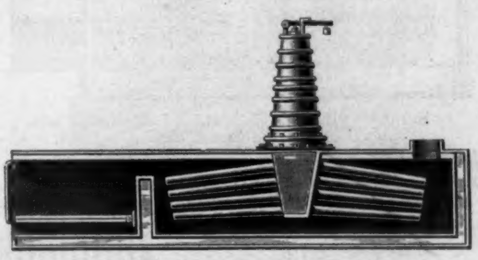


Fig. 1.—JOHN COX STEVENS, 1805.

Transactions of American Society Mechanical Engineers, Vol. VI., p. 601.

steamboat on the Hudson River in 1805. It consisted of a vertical steam and water reservoir, the lower portion of which projected downward into a fire-box. The main heating surface was made up of closed ended tubes radiating from the fire box section at a slight inclination from the horizontal.

Fig. 2.—THE JOLY BOILER, 1857.

Burgh on Boilers, p. 166.

Mr. Joly first used this unit in the construction of a *sectional* boiler (fig. 2) in 1857, feeding each vertical drop tube with a separate internal pipe, extending nearly to the bottom.

Merryweather brought out a vertical fire-box boiler (fig. 3) in 1862, using drop tubes hanging vertically from the crown-

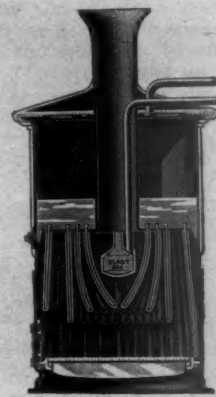


Fig. 3.—THE MERRYWEATHER BOILER, 1862.

British Patent, 1862.

sheet, and adding inside circulation tubes. This was used principally for fire-engine purposes, and as rapidity of steaming was the main requirement, lasting qualities and economy being secondary, it met with fair success for its special work.

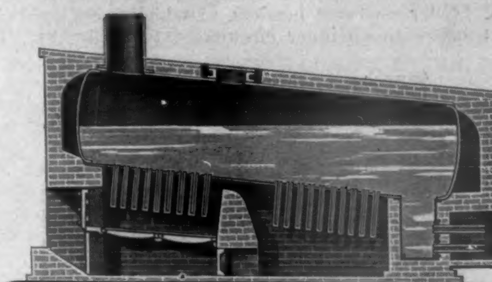


Fig. 4.—THE FIELD BOILER, 1866.

Burgh on Boilers, p. 142.

Field used a cylinder boiler (fig. 4) slightly inclined from the horizontal, with radiating drop tubes fitted to the lower side.

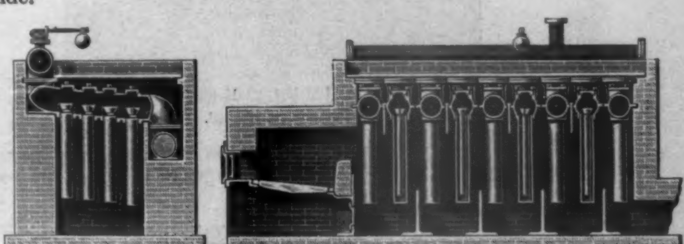


Fig. 5.—THE FIELD BOILER, 1867.

Transactions Society of Engineers. Pendred's Paper on Water-Tube Boilers, 1867.

Field also re-invented, with slight changes, the Joly boiler of 1857, and adopted Merryweather's inside circulating tubes.

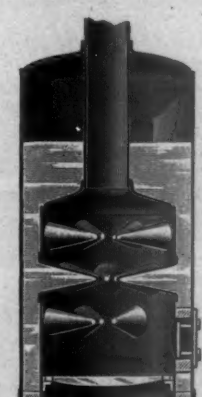


Fig. 6.—THE FLETCHER BOILER, 1869.

Burgh on Boilers, p. 85.

Fletcher used a vertical fire-box boiler (fig. 6) with horizontal cone-shaped tubes radiating from the sides of the fire-box toward the centre. This is probably the least objectionable form of the closed-end tube.

* From advance sheets of a publication by the Babcock & Wilcox Company.

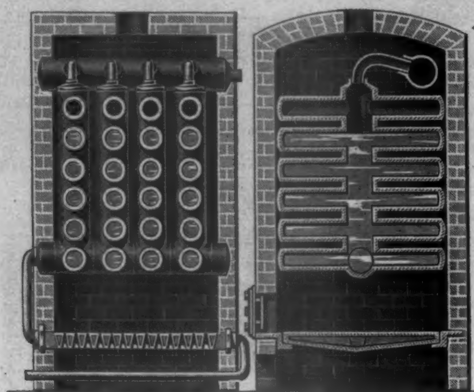


Fig. 7.—THE B. T. BABBITT BOILER, 1869.
Trade Circular Issued in New York.

B. T. Babbitt, of New York, used a cast-iron construction of vertical tubes (fig. 7) connected together, top and bottom, each vertical tube having horizontal radial tubes on each side, thoroughly demonstrating the folly of placing a combination of thick cast metal and scale between fire and water.

J. A. Miller used cast headers, to which were fixed closed ended tubes with an inner circulating tube (fig. 8). These

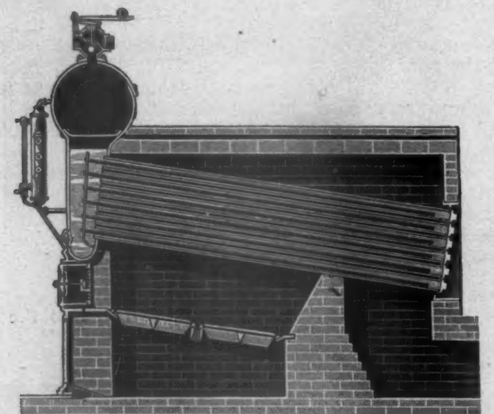


Fig. 8.—THE MILLER BOILER, 1870.
U. S. Patent No. 106,388.

stood at an angle of about 15° from the horizontal, and were of such length as to allow of two passages of the gases across them.

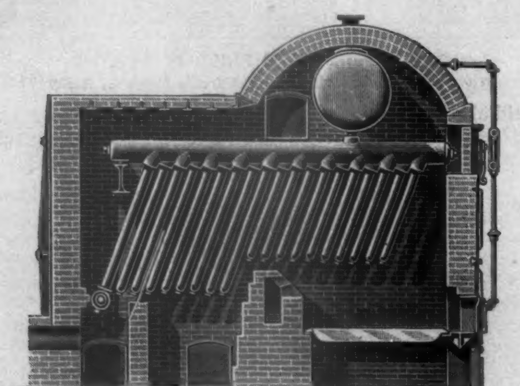


Fig. 9.—THE ALLEN BOILER, 1871.
Report of American Institute Fair Tests, 1871.

Allen nearly duplicated Joly of 1857 and Field of 1866, using cast-iron drop tubes (screwed into a horizontal tube at the top), slightly inclined from the vertical (fig. 9).

Wiegand connected groups of vertical tubes, having inside circulating tubes, to an overhead steam and water reservoir (fig. 10). Caps were screwed on the bottom of the tubes for cleaning(?), but they generally came off without the assistance of a wrench.

Plambeck & Darkin modified Fletcher's design of 1869, substituting cylindrical for conical tubes and making his outer shell removable (fig. 11). This being taken off, the tubes could be bored out.

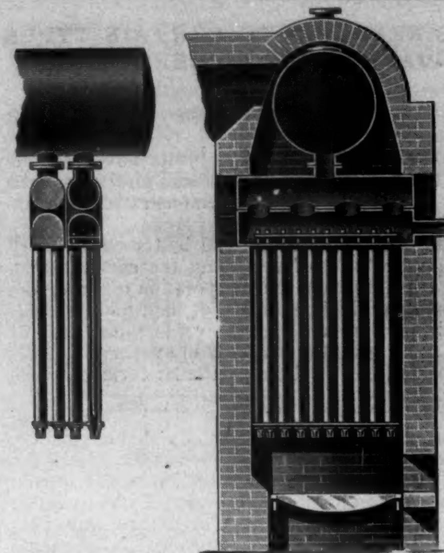


Fig. 10.—THE WIEGAND BOILER, 1872.
Judges' Report, Centennial Exhibition, 1876.

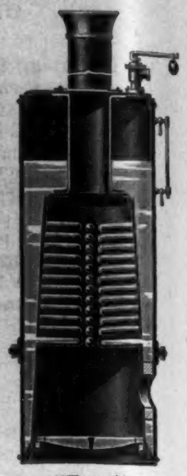


Fig. 11.
THE PLAMBECK & DARKIN BOILER.
Trade Circular, about 1874.

W. E. Kelley, of New Brunswick, N. J., adopted J. A. Miller's design of 1870, adding a drum or so and a subterranean feed and blow-off pipe (fig. 12). He was also among the first to put in superheating surface, to dry the wet steam made, due to his construction.

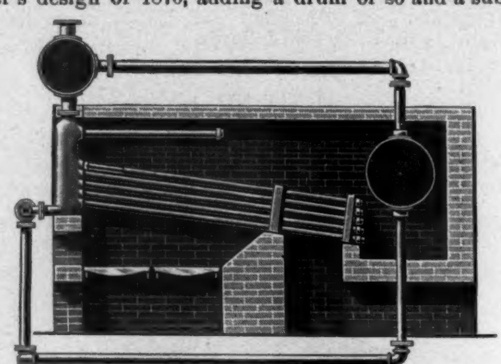


Fig. 12.—THE W. E. KELLEY BOILER, 1876.
Judges' Report, Centennial Exhibition, 1876.

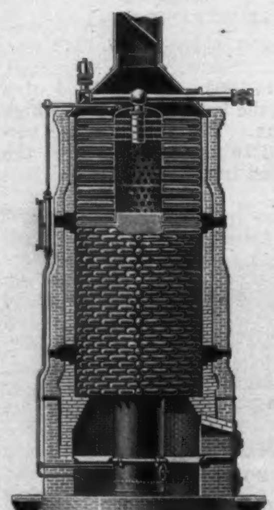


Fig. 13.—THE HAZLETON BOILER, 1881.
Trade Circular.

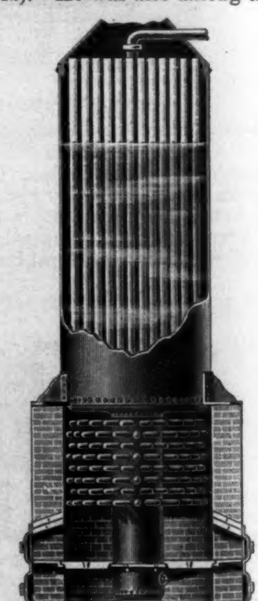


Fig. 14.—THE GEORGE H. CORLISS BOILER.
In Service about 1862.

M. Hazleton turned Plambeck & Darkin's 1874 boiler inside out, using a vertical cylinder with radial tubes (fig. 13), making wet steam and drying it afterward in the upper set of superheating tubes. This boiler has also appeared and disappeared under the names of "Adams," "Porcupine," "Minerva," and others.

Even **George H. Corliss** was seduced by this unit. He made

a boiler (fig. 14) with its lower half like a Hazleton and its upper half of his regular vertical tubular.

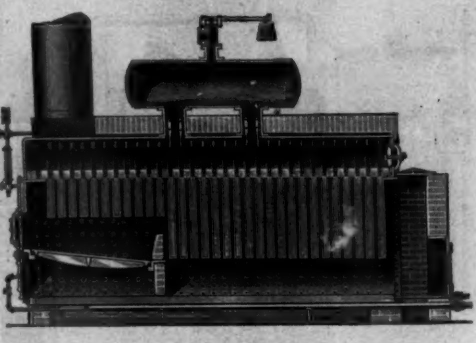


FIG. 15.—THE KINGSLEY BOILER, 1883.
From Kingsley & Hook's Trade Circular issued in Kansas City, Kan.

Kingsley brought out an internal fire-box and flue boiler (fig. 15) with stayed sides and crown-sheet, and vertical tubes dropped from the latter, being a slight modification of Marshall's British patent of 1864.

Allan Stirling exploited another form in Canada, called the Field-Stirling boiler (fig. 16), joining to the closed-tube unit, bent tubes and stayed surfaces, with a wrought-metal mud-drum at the bottom, placed in the most advantageous position for both interior and exterior corrosion.

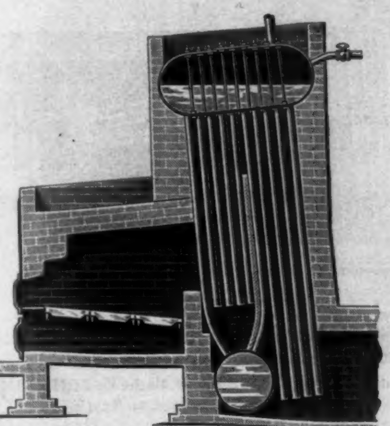


FIG. 16.—THE ALLAN STIRLING BOILER, 1887.
From Photographs issued by the Inventor.

The failure of the closed-end tube as a unit of heating surface has been accelerated by the inadequate facilities for circulation. The incoming current of water has to fight its way in against the outgoing current of steam and water, slightly modified where inner circulation tubes or diaphragms are used; and in all cases the tendency is to deposit the scale-forming material at the ends of the tubes where the current slows down, due to its change of direction, with the inevitable result of burning out.

Nearly all of the above boilers are practically out of the market.

Can any success be expected by re-inventing in any new combination this unit of a closed-ended tube?

It has been tried and failed in the following positions:

HORIZONTAL.		VERTICAL.	
By Fletcher	1869	By Joly	1857
" Babbitt	1869	" Merryweather	1867
" Plambeck & Darkin	1874	" Field	1867
" Hazleton	1881	" Wiegand	1872
" Corliss	1882	" Kingsley	1883

INCLINED FROM HORIZONTAL.		INCLINED FROM VERTICAL.	
By Stevens	1805	By Field	1866
" Miller	1870	" Allen	1871
" Kelley	1876	" Stirling	1887

There is only one position in which it has *not* been tried, and that is standing vertical with the closed end up.

Who will invent this for the waiting public?

UNIT NO. 2.

THE BENT TUBE, ITS ENDS CONNECTED WITH STEAM AND WATER SPACES.

This embraces all forms short of circular or box coils, the particular form given it by various inventors being simply a matter of degree. All are inaccessible for cleaning.

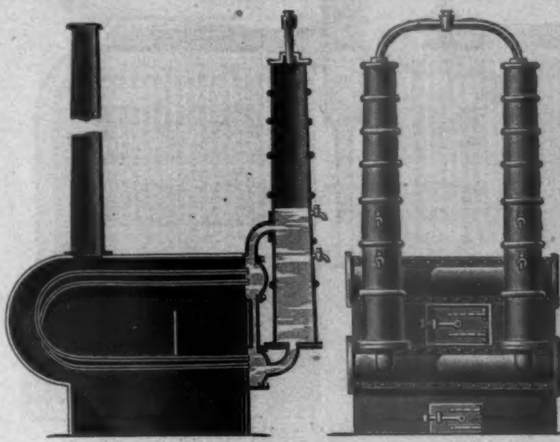


FIG. 17.—THE GOLDSWORTHY GURNEY BOILER, 1826.
Luke Hebert's Cyclopedia, London, 1828.

Goldsworthy Gurney, an English inventor, was the originator of this unit, using it in the boiler (fig. 17) of a steam road-carriage in 1826. A pair of vertical steam and water reservoirs were connected at their bottom, and about half-way up their height, by cross pipes from which a series of bent-tube units were projected into the fire-box. The tubes received their water supply at their lower end and delivered a mixed current of steam and water at about the water-line, in a continuous round of circulation. The lower row of tubes served as grates.

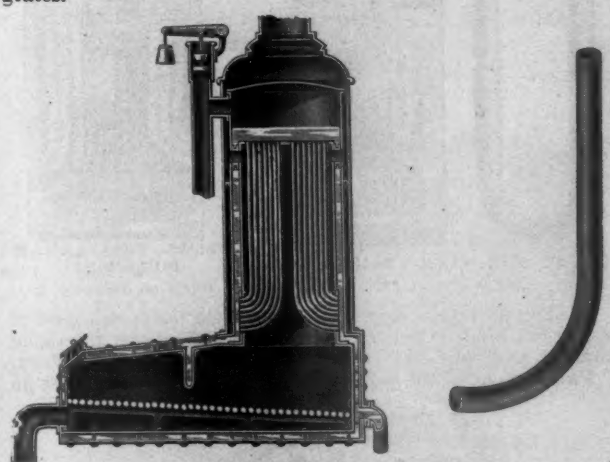


FIG. 18.—THE CHURCH BOILER, 1832.
London "Engineer," Aug. 17th, 1894.

Church built a boiler (fig. 18) for a road-carriage, with a locomotive fire-box having a vertical cylindrical extension at one end, filled with bent tubes, connecting the sides of the fire-box with the crown-sheet, and with side openings in the shape of fire-tubes extending through the shell at the top, for taking off the gases.

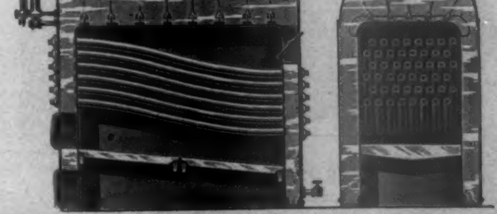


FIG. 19.—THE STEPHEN WILCOX BOILER, 1856.
"Steam," 1889.

Stephen Wilcox was the first person to use inclined tubes connecting water spaces, front and rear, with an overhead

steam and water reservoir (fig. 19). The tubes were bent at a slightly reversed curve, extending over nearly the whole length of the tube, but were inaccessible for cleaning.

Rowan introduced a boiler (fig. 20) made up of a series of units placed side by side, each unit consisting of an upper

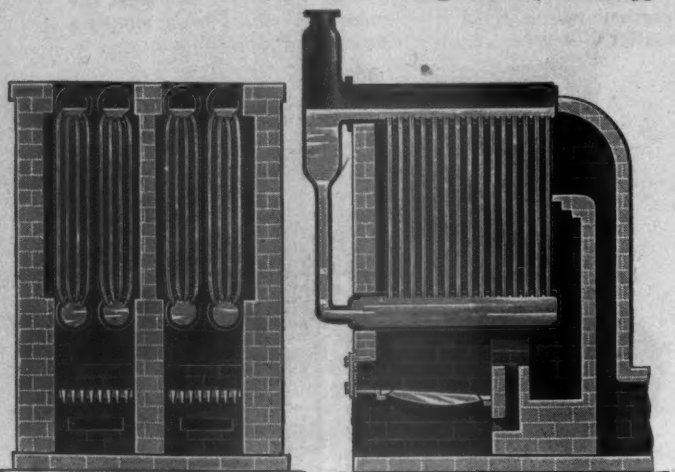


FIG. 20.—THE ROWAN BOILER, 1865.
British Patent, 1865.

and a lower horizontal drum connected by a series of bent-ended heating tubes, and at their ends outside the setting, with down-take pipes of large diameter.

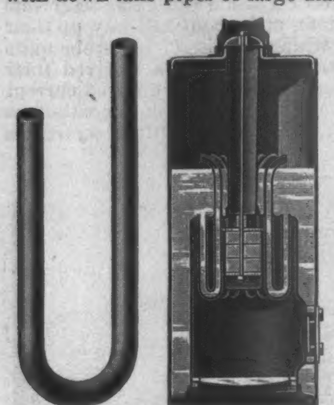


FIG. 21.—THE WILSON BOILER, 1865.
British Patent, 1865.

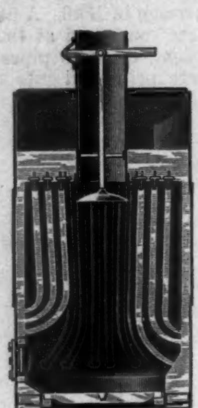


FIG. 22.—THE PAXMAN BOILER, 1870.
Burgh on Boilers, p. 94.

Wilson dropped a series of U tubes from the crown-sheet of a vertical fire-box boiler (fig. 21) one end of the U passing through and considerably above the line of the crown-sheet.

Paxman cut off the locomotive fire-box from Church's design

FIG. 23.—THE PHLEGER BOILER, 1871.
American Institute Exhibition Tests, 1871.

of 1832, and put in grates, leaving it a vertical cylindrical boiler (fig. 22). He placed deflectors above the ends of the tubes to prevent geyser action.

Phleger used Gurney's 1826 U tubes for fire-bars, adding a second series above for heating tubes, and, above them, a large steam and water-drum (fig. 23).

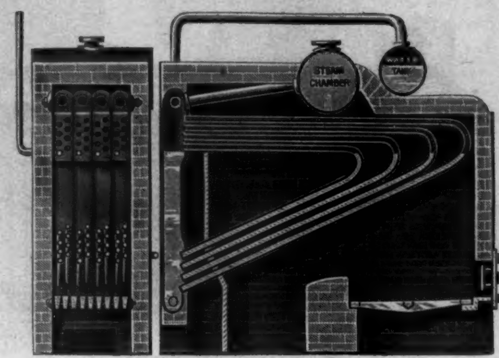


FIG. 24.—THE ALLEN BOILER, 1872.
British Patent, 1872.

Allen used Gurney's U tubes, in vertical headers connected in series, side by side, and built the fire below instead of the middle of the bank of tubes (fig. 24).

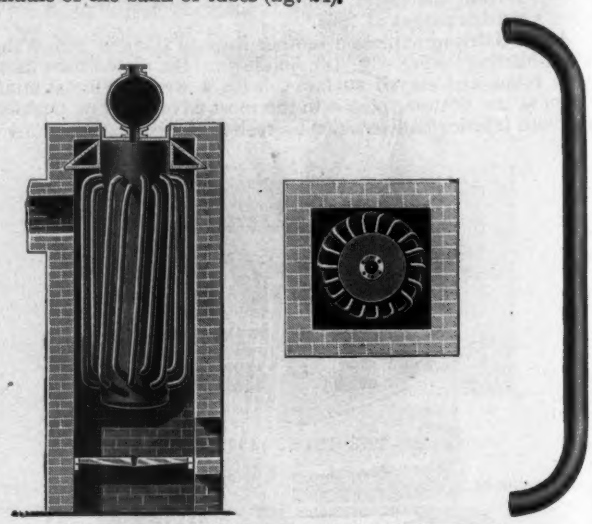


FIG. 25.—THE ROGERS & BLACK BOILER, 1876.
Judges' Report, Centennial Exhibition.

Rogers & Black placed a series of U tubes on the outside of a vertical shell, surrounded it with a brick setting and placed grates beneath it (fig. 25).

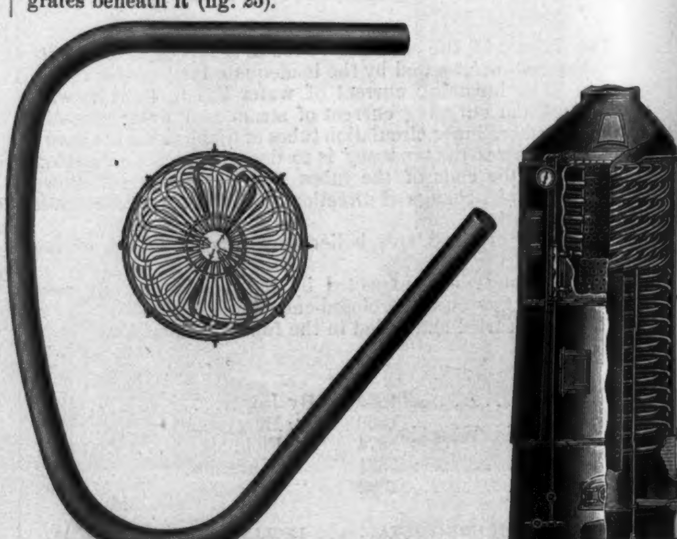


FIG. 26.—THE T. MORRIN BOILER, 1883.
U. S. Patent No. 309,727.

T. Morrin designed the "Climax" boiler (fig. 26), using a vertical cylinder punched full of holes (similar to Hazleton's 1881), expanding into them the ends of a series of crooked

loops of pipe (an exaggeration of Rogers & Black's 1876) placed at a slight inclination from the horizontal. The upper pipes were used to dry the steam made by the lower ones.

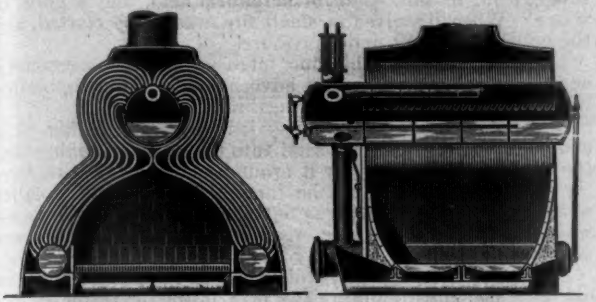


FIG. 27.—THE THORNYCROFT BOILER, 1887.
"Engineering," July 22, 1887.

Thornycroft modified Rowan's 1865 design by using two cylinders at the bottom instead of one (fig. 27), placed the grates between them and put several extra bends in the tubes

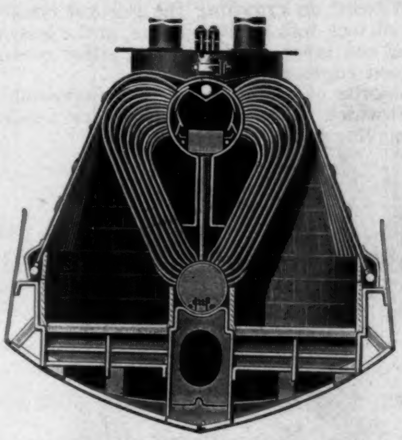


FIG. 28.—THE THORNYCROFT, 1894.
The "Daring" Type.

to increase the amount of tube surface between the points of fastening, delivering the up-current above the water-line. He retained the down-take tube, outside the furnace.

His 1894, the "Daring" type of boiler (fig. 28), reverts more nearly to Rowan's original units.

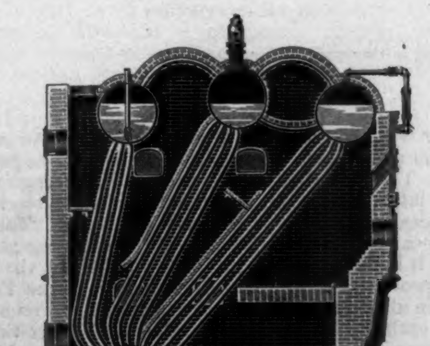


FIG. 29.—THE ALLAN STIRLING BOILER, 1888.
Trade Circular.

Allan Stirling, who used the closed-end unit in 1887, adapted the unit designed by Rowan in 1865 to a new construction (fig. 29), leaving out the opportunity for definite circulation given by the balance pipes used by the previous inventor, which secured a definite water level, retaining his original idea of a wrought-metal mud-drum exposed to exterior corrosion.

Cowles followed Thornycroft's 1887 design very closely, adding a mass of tubes at the rear of the grate. His design

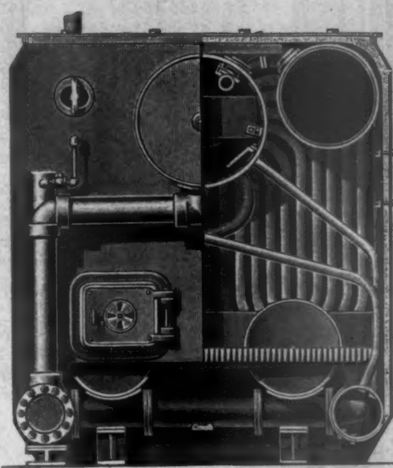


FIG. 30.—THE COWLES BOILER, 1880.
U. S. Patent No. 396,545.

(fig. 30), however, does not allow as large a proportion of grate surface to room occupied as Thornycroft's.

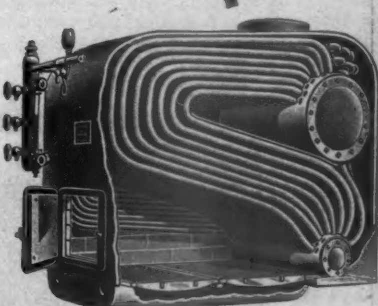


FIG. 31.—THE MOSHER SINGLE BOILER, 1890.

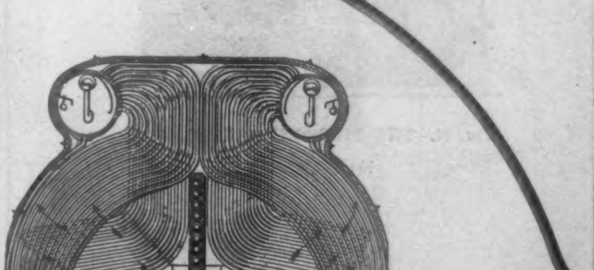


FIG. 32.—THE MOSHER DOUBLE BOILER, 1890.
Report International Engineering Congress, 1894.

Mosher used two drums placed one below the other, bent the upper ends of Thornycroft's 1887 tubes in a reverse position, and on larger sizes it was arranged Siamese-twin fashion.

Hyde either turned Paxman's 1870 design inside out, or cut off the top (fig. 33) and put a head on Rogers & Black's boiler of 1876. Mr. Smith also invented and christened it with his family name.

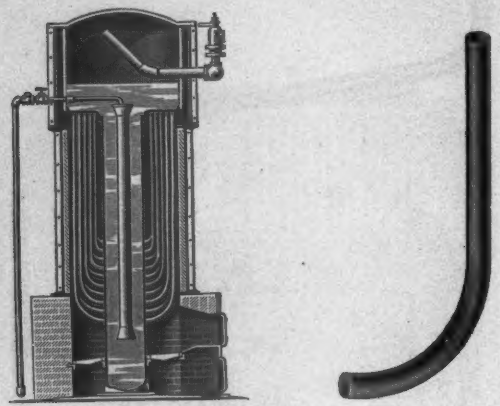


FIG. 33.—THE HYDE BOILER, 1893.

Trade Circular.

Pierpont added two more cylinders to the bottom of Stirling's design(?), and altered the name. In this boiler three wrought-metal mud-drums were exposed to exterior corrosion.

With all these examples before them persons are still trying to bend tubes into other forms, so as to "make a new boiler."

A FEW IDEAS AS TO CLEANING.

Strange to relate, the originator of this bent-pipe unit—Gurney, in 1826—recognized the necessity of removing the

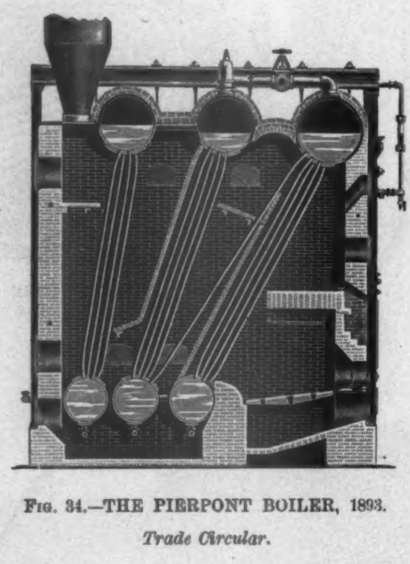


FIG. 34.—THE PIERPONT BOILER, 1893.

Trade Circular.

scale left by the evaporation of water, he not having attained to either of the theories of keeping it clean by the force of circulation or by evaporating salts of lime into steam. In one of his publications he recommended "for a boiler made of iron tubes, the use of one part of muriatic acid to 100 parts of water, to be left in the boiler a sufficient length of time to dissolve the incrustation; and for a boiler made of copper tubes, 1 lb. of salt, ¼ lb. of sulphuric acid, and 4 galls. of water. When dissolved, a small fire was to be started, and the boiler blown out under pressure."

Later exploiters in this line, more versed in "commercial engineering," have generally advocated the rapid-circulation theory as an efficient cleaning medium.

One notable maker recommended the introduction of a couple of buckets of sharp sand into the boiler, claiming that the circulation would carry it around and *scour the scale from the tubes*. Whether or not he furnished a particular quality of sand that would just wear out at the point when the scale was removed, and so save wear on the boiler, we are not posted.

Another maker strung a tube scraper on a chain, like an old-fashioned chain pump. The man in the top drum let this down through one of the tubes (if the scale had not closed it up too much) to a man in the bottom drum, and these unfortunate specimens of humanity were supposed to sit like two half-closed jack-knives, see-sawing the scraper back and forth, until either the scale or their muscles were worn out.

The early designs were creditable attempts to carry high pressures safely, with the means then available. The later ones are all based on crowding the greatest possible amount of heating surface into a given space, at the least prime cost for material and labor, irrespective of either economy, durability, or good engineering.

In the majority of these designs it is impossible to clean a tube, to tell which tube leaks, or to replace a defective tube without removing several good ones.

(TO BE CONTINUED.)

NOTES AND NEWS.

New Car-wheel Works at Raleigh, N. C.—The new car-wheel works which have been built at Raleigh have just been started up. The Lobdell car-wheel people of Wilmington, Del., are largely interested in the new plant, the other stock being owned by local capitalists. The stock is $100,000. The works will have a capacity of 50 wheels a day, employing about 60 hands, and it is the intention gradually to increase the works, as they expect to sell to roads as far north as the Potomac River and in all the more Southern States. The iron ore used will come entirely from North Carolina and other Southern States. There is already a car factory at Raleigh which has been in existence for 12 years, and although that plant and the wheel works are separate concerns, they are built side by side and will operate largely in conjunction.

An Electrical Vehicle in London.—Details of an electrical bus built by E. J. Clubbe & Co., and which is now at work in the streets of London, has been received. It can carry 26 passengers, and its power is furnished by storage batteries carried under the seats. The motor is in a box hung between the back wheels to which the power is applied. The total weight of bus with load of passengers is a trifle over 6 tons, 2¼ of which belongs to the empty vehicle; it is under perfect control, and can be run at any desirable speed up to 10 miles an hour. The cost of operation is claimed to be less than 6 cents a mile, and it can make 580 miles a week.

THE DETERIORATION OF LOCOMOTIVE AND MARINE BOILERS DUE TO EXPANSION AND THE MEANS OF LESSENING THE SAME.*

By Herr Lentz.

(*Continued from page 137.*)

For 30 years, and even now, the beloved crown-bars have been applied in England, where they undoubtedly represent

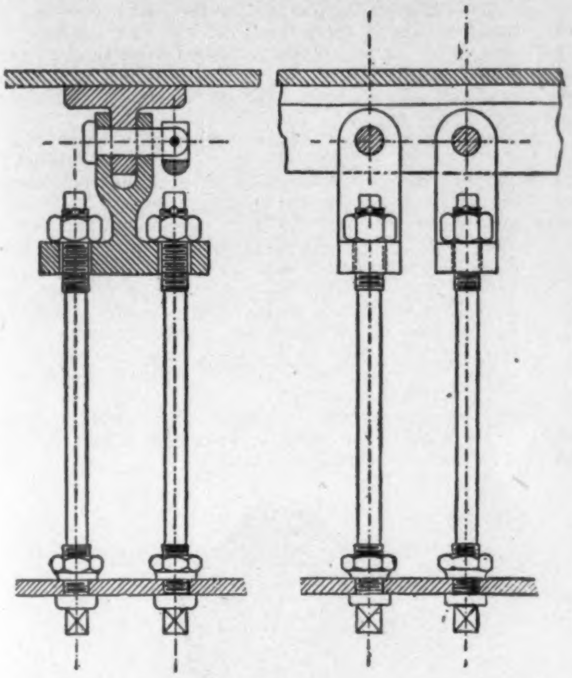


Fig. 7.

FLEXIBLE CROWN-SHEET STAYS FOR BELPAIRE BOILER.

the prevailing practice, since by reason of the play of the crown-bar suspension rods the vertical motion of the fire-box is in no way checked. Later the Belpaire arrangement of crown-sheet bracing came into vogue, which left the cross expansion free as far as the crown-sheet is concerned, but caused such a modification to be made in the half-round external shell of the fire-box that, while the construction is greatly simplified, the fire-box was made very much stiffer and the elasticity in a vertical direction is hampered. Hence unless the forward stay-bolts are susceptible of a slight motion the tube-sheet must be subjected to a heavy strain.

It is strongly recommended that in this fire-box movable stay-bolts be used in the four front rows and on both sides in the lateral rows. In the latest type of Belpaire boilers that have been introduced on the Belgian State railroads the crown-sheet is perfectly flat, and both the front rows of stay-bolts are movable and are made like that shown in fig. 7. The Pennsylvania Railroad has in use a very rational form of Belpaire fire-box on its locomotives with two rows of movable stay-bolts at the front and back (fig. 8). As stay-bolt holders must yield about ⅛ in., as they are stiff, and as the stay-bolts sustain this bending in a length of about 2⅜ in., there is a considerable inclination to break. This can be prevented by the Belgian method shown in fig. 9, wherein the connection to the tube-sheet is made over a long section that yields easily. It would therefore appear that the many breakages of stay-bolts that occur in the side-sheets result from the fact that they are not properly put in.

From the mud-ring up, all parts of the inner fire-box rise, so that we must in no way hinder this movement, but should put in the stay-bolts so that they can easily yield, and they should be screwed in horizontally, as correctly shown in fig. 4 (see page 135). Furthermore, stay-bolts should stand at right angles or radial to the sheets, so that they may serve for the support of the walls; otherwise they are in so unfavorable a position for carrying either a tensile or compression strain that they break. Investigations show that the front and back vertical rows, as well as the upper horizontal rows, are the ones that are especially liable to break. It is astonishing, moreover, to find what examples of preposterous arrangements of stay-bolts we find in American boilers, examples of which are given in fig. 10. The two halves of these cross-sections of fire-boxes are taken from boilers built by a prominent American shop for roads running into Chicago. In the Wootten fire-box, as well as in the other, the stay-bolts are set radially throughout. It is not clear where an allowance can be found for the greater expansion of the inner fire-box, but it does seem that both stay-bolts and fire-box must soon become distorted. Instead of using the Wootten fire-box, it would seem to be far more rational to substitute one of the Belpaire type.

Torpedo-boat boilers (fig. 11) that are for the most part built after the locomotive pattern, and which are subjected to violent forcing, whereby a very high steam production is attained with a correspondingly high temperature of the sheets, offer many difficulties in maintaining the tubes tight in the sheets. We screw the tubes into the fire-box tube sheet as tightly as we can, then roll them out and head them over, and yet when we put them under a forced draft they will not remain tight. This trouble can be almost entirely obviated by making the tube-sheet at the smoke-box end flexible, as shown in fig. 12. The tubes are then free to expand. It is in a line with the recommendation that movable crown-stays and stay-bolts be used in all places where it may be necessary. The usual type of marine boiler of large diameter (fig. 13) with several furnaces and return tubes, whether it be made single or double ended, shows that a riveted connection of the furnace flues with the outer shell of the boiler and the combustion chamber and other portions will be very apt to be leaky. In order to hold the sheets together in a better manner it is essential that they should be stayed, and then there is less trouble about the riveting leaking.

It follows, then, that the portion of the flue above the grates becomes highly heated and is therefore expanded more than the outer shell, so that the sheets at the front end are forced together. Then, since the sheets are strongly braced by the tubes above, it results that the riveting is apt to be distorted where it lies in contact with the fire. This great evil can be removed if we will but give the furnace flue a free chance to expand by inserting a flexible ring, as shown in fig. 14. Movable stay-bolts placed along the rim of the fire-box will be found to materially help in allowing the tubes to expand longitudinally.

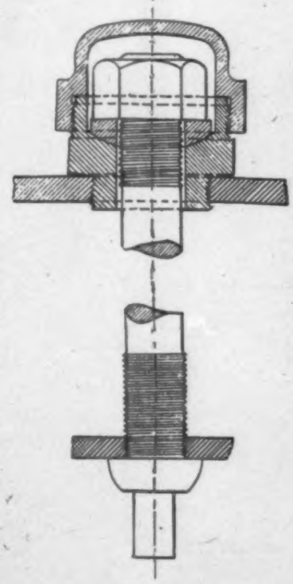


Fig. 8.

SELF-ADJUSTING STAY-BOLTS FOR BELPAIRE BOILERS USED ON AMERICAN RAILROADS.

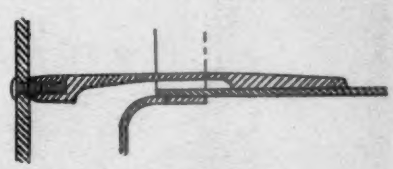


Fig. 9.

STAY-BOLT HOLDER FOR BELPAIRE BOILER ON THE BELGIAN STATE RAILWAY.

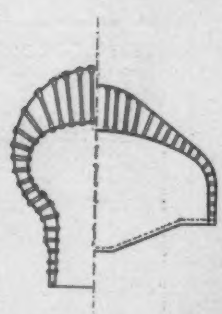


Fig. 10.

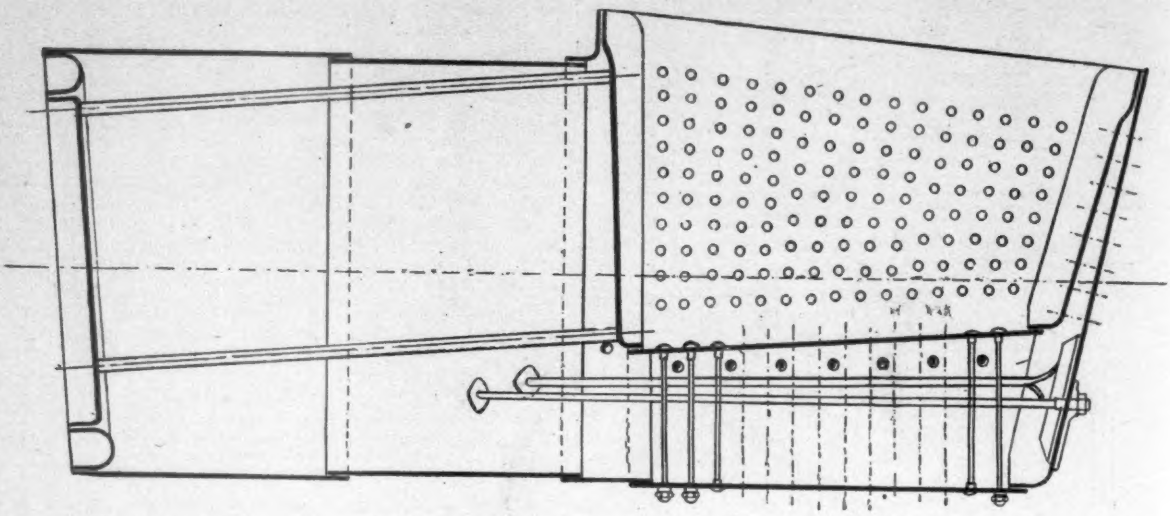
ARRANGEMENT OF STAY-BOLTS IN AMERICAN LOCOMOTIVE BOILERS.

Locomotives with corrugated furnaces manifest phenomena similar to those mentioned for marine boilers, except that they

* Paper read before the *Verein für Eisenbahnkunde.*

Fig. 11.

OLD CONSTRUCTION OF TORPEDO-BOAT BOILERS.



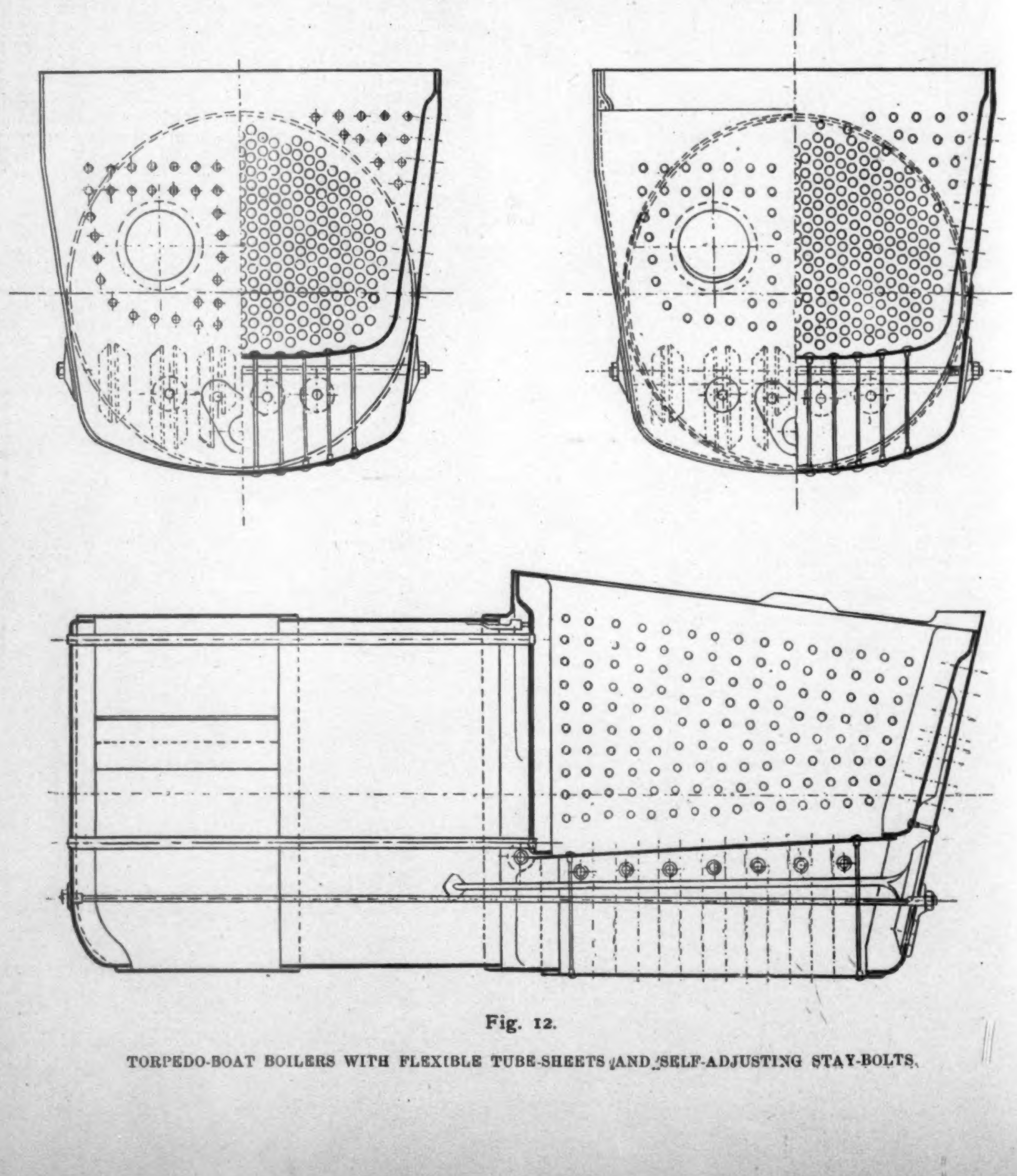


Fig. 12.

TORPEDO-BOAT BOILERS WITH FLEXIBLE TUBE-SHEETS AND SELF-ADJUSTING STAY-BOLTS.

are exaggerated over the latter in that the expansion of the furnace must be added to that of the tubes. In the stayless boiler the back end of the corrugated furnace is rigidly fastened to the outer shell of the boiler, while at the front end there is a strong and rigidly attached smoke-box tube sheet, so that the excess of expansion of the inner portion can only take place in the corrugated flue.

The general impression is that the corrugated furnace flue is very elastic longitudinally, yet the experiments of Schulz-Knaudt, which have extended over a period of two and a half years, and which have been fully published in *Glaser's Annalen*, show that the compressibility is very limited, and with the greater thicknesses of metal the limit of elasticity is soon reached. While these experiments were made with cold flues, it must be remembered that, at higher temperatures, the limit of elasticity will be reached much earlier, so that care must be taken that this limit of elasticity is not exceeded and a deformation set up which will manifest itself in the form of a crack.

Herewith an engraving (fig. 15) is given showing the construction of a stayless boiler in use on an express passenger locomotive running on the railway along the left bank of the Rhine, and which had the misfortune to collapse the corrugated flue at Bonn on February 6, 1894. That the catastrophe partook of the nature of an explosion was due to the fact that the lower side struck against the edge of the iron casting that carried the fire-brick, which had worn smoothly into the sound material for about a foot; this cross seam then extended about 4 in. sideways and ripped open the whole length. Had no iron casting for carrying the fire-brick been used, but all the fire-

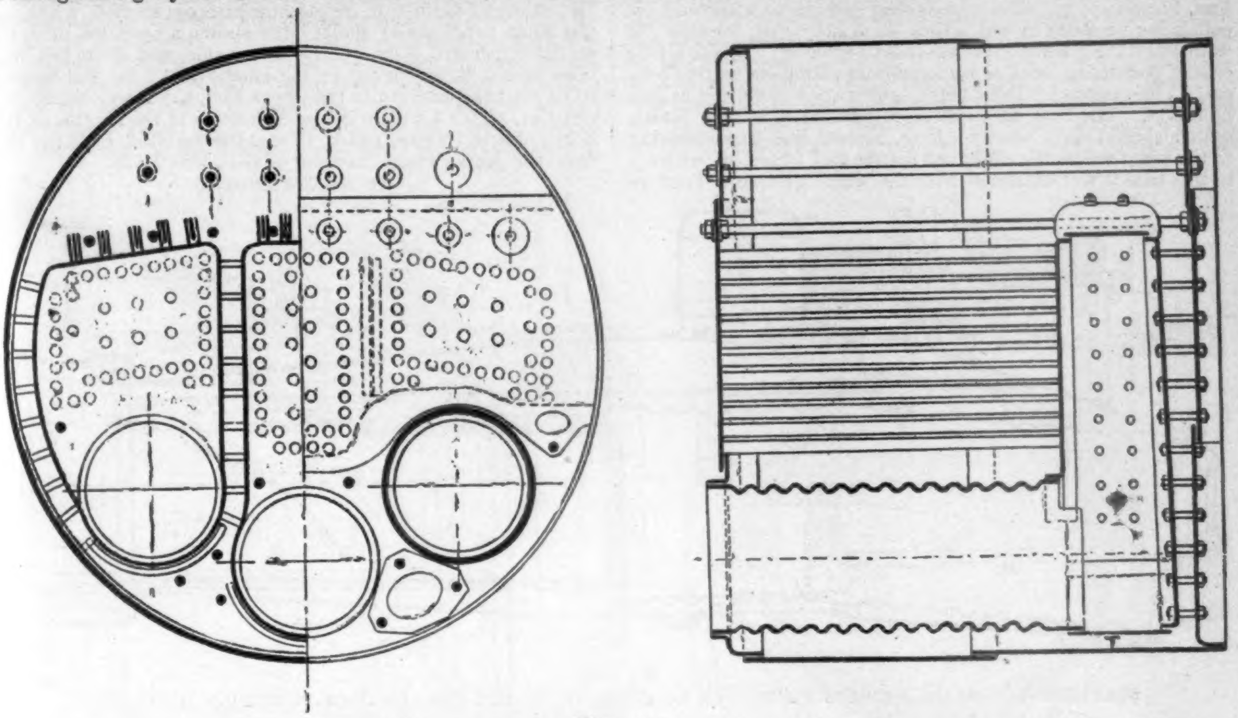


Fig. 13.
OLD CONSTRUCTION OF MARINE BOILER.

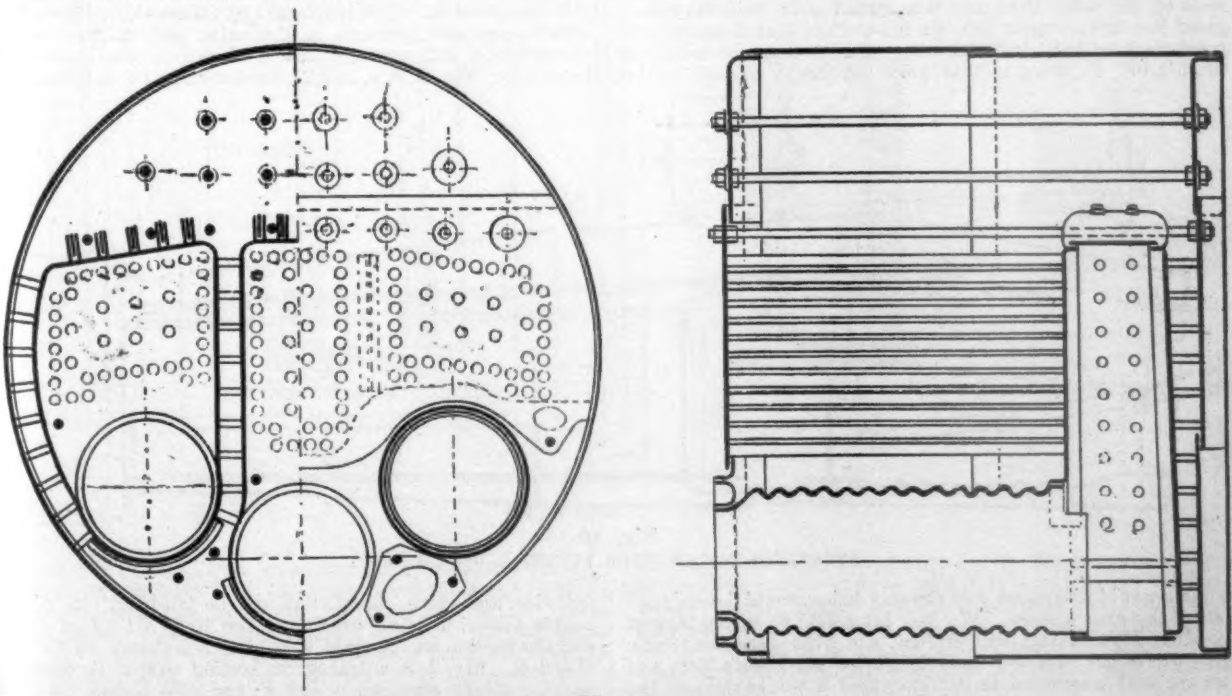


Fig. 14.
MARINE BOILER WITH FLEXIBLE RING FOR THE CORRUGATED FLUE.

brick been put in with mason work, there would simply have been a collapsing without a rent, and no steam would have escaped, nor would the accident have partaken of the nature of an explosion.

The corrugations had been put in by hand, and were, therefore, imperfect, but they were strong enough to withstand the collapsing pressure to which they were subjected, for they did withstand the yielding of the sheet perfectly. It was a true case of collapsing, such as we sometimes witness in marine boilers. The reasons for this sudden deformation could not at first be found. The first supposition attributed it to low water, which should have shown a long, narrow line corresponding to the point where the contained matter had boiled on, whereas in this case it was extended over the whole surface. Then an vided that the corrugated tube preserves its circular form of cross section. Measurements taken of furnaces which were removed from locomotives soon after this accident, and which had been in service for a longer time, showed that in boilers which could not be considered strong the corrugated furnaces had changed neither in length nor in cross section, while, on the other hand, boiler shells have shown a variation of $\frac{5}{16}$ in. on the upper and $\frac{1}{16}$ in. on the lower side, and there has likewise been a flattening out to the extent of 1.2 in. that seemed to be confined entirely to the upper half, the lower remaining circular. This 1.2 in. was the difference in the lengths of the horizontal and vertical axes, so that the variation of either one from the proper mean diameter of shell was 0.6 in.

(TO BE CONTINUED.)

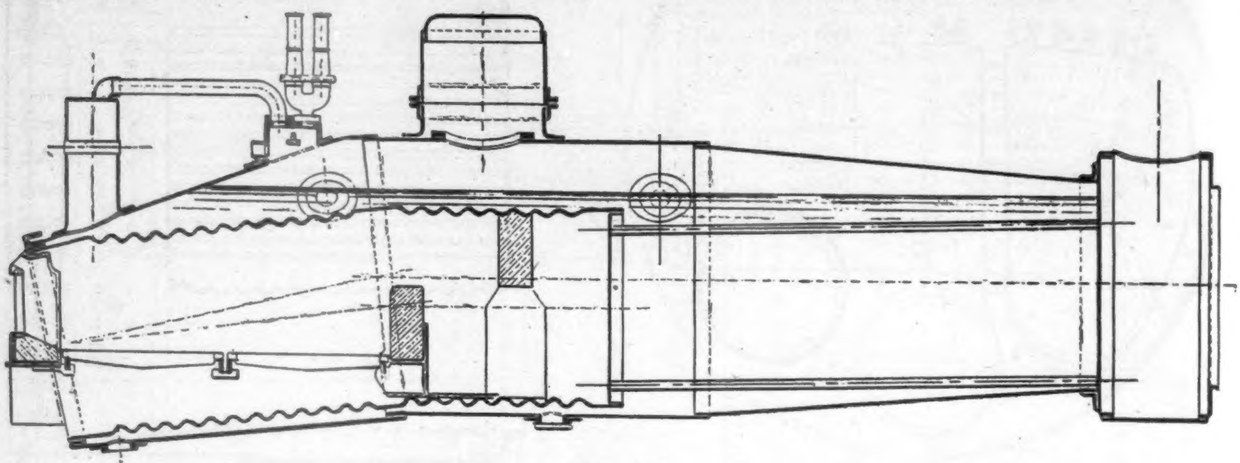


Fig. 15.
STAYLESS BOILER ON EXPRESS PASSENGER LOCOMOTIVE OF THE LEFT-BANK-OF-THE-RHINE RAILWAY.

explanation was sought in the scale that contained magnesia and fatty matter, which might result from the water standing, and which, on analysis, was shown to contain from 12 to 22 per cent. of the hydrate of magnesia, with just a trace of fatty matter.

The analysis showing the highest percentage of scale was of scale taken from an express passenger locomotive running on the left bank of the Rhine Railway. If now a layer of scale of the same thickness was spread over both the corrugated flue and a copper fire-box it is evident that the same temperature must exist in both cases. The temperature could not reach 1,100° F., since at that point the tensile strength of the copper would disappear, and the stay-bolts would be stripped out of the crown-sheet. We may take 925° F. as the highest possible limit of this temperature, and even here the tensile strength of the copper is only 7,100 lbs. per square inch, and we are well warranted in thinking that it would strip off the stay-bolts.

At this same temperature of 925° the tensile strength of wrought iron is 42,600 lbs. and the limit of elasticity 14,200 lbs., so that with a steam pressure of 14 atmospheres, as we have had in this case, we would not expect to find any deformation; and even at 1,300°, where the metal begins to show a dark-red color, it still has a tensile strength of 14,200 lbs. per square inch, which is still sufficient to resist the pressure pro-

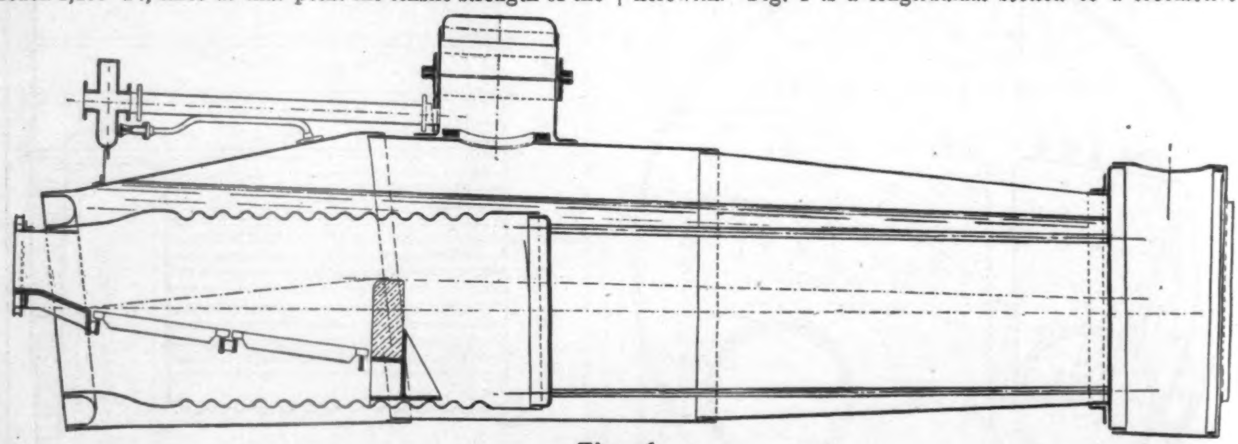


Fig. 16.
STAYLESS BOILER WITH FLEXIBLE BACK HEAD.

FAY'S ENGINE VALVE.

It is well known that one of the defects of the ordinary Howe or Stephenson link-motion valve-gear is that when working at short points of cut-off it causes an excessive amount of compression in the cylinder by the premature closing of the exhaust some time before the piston has completed its stroke. The object of Fay's engine valve is to reduce the amount of this compression. This is effected by means of supplementary steam ports and passages in the valve and cylinder, whose construction and arrangement is shown in the engravings herewith. Fig. 1 is a longitudinal section of a locomotive cylinder, and valve, the portion on the left-hand side of the centre line *A B* being drawn on the lines *A* 1 2 *B* of fig. 2, and the portion on the right side of *A B* is drawn on the line *C D* 2 *B*. Fig. 2 is a transverse section drawn through the supplementary passages *a* and *a'*, and also shows the main steam passage *c* in section in order to represent the way in which communication is formed between the latter and the supplementary passages *a* and *a'*. Fig. 3 is a plan view of the cylinder, in which a half sectional plan of the valve drawn on the line *d e* of fig. 1 is shown on the lower half below the centre line *E F*. Fig. 4 is an inverted plan of the valve, its face being shaded with horizontal lines in order to show the form of the supplementary ports *f* and *f'* more clearly.

The general purpose of the invention is to establish communication between the end of the cylinder toward which the piston is moving and the opposite end after compression has commenced in the former and the latter is in communication with the exhaust. By the means which are provided the compressed steam can flow through the supplementary ports and passages to the opposite end of the cylinder, and can then escape into the exhaust. To accomplish this supplementary passage *a* and *b*, consisting of holes about $\frac{3}{8}$ in. in diameter, are drilled from the valve face *G G*, so as to communicate with the inside of the cylinder, the openings *g* and *h*, which communicate with the latter, being so located that they are uncovered by the piston about the time—or soon after—compression has commenced, and it has then uncovered the opening *h*, by which the passage *a* communicates with the inside of the cylinder. The valve is also shown in the position it would occupy soon after compression has commenced in the left-hand end *H* of the cylinder when the steam port *c*, which communicates with the opposite end of the cylinder, is opened to the exhaust. When the valve has reached this position the extremities of the groove *f'* in the valve face lap over the openings *j j'* in the valve-seat, as shown in figs. 1 and 3. Communication is thus established between the right-hand end *H* of the cylinder through the steam passage *c'* (shown by dotted lines in fig. 1), the groove *f'*, openings *j* and *j'*, and passages *a* and *a'* to the left-hand end *I* of the cylinder; and as this is in com-

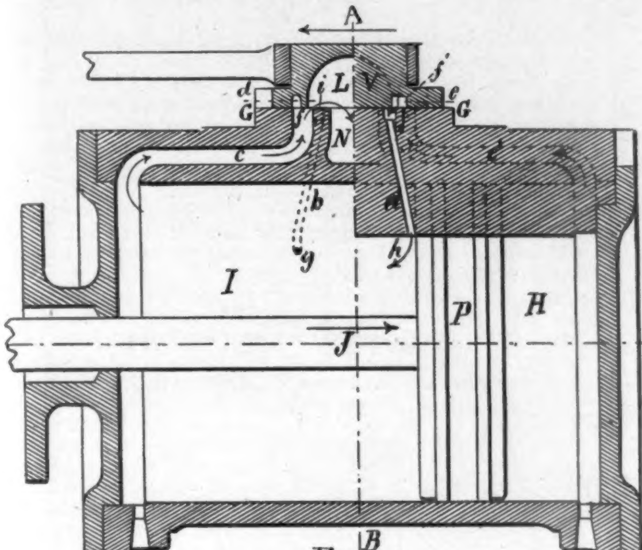


Fig. 1

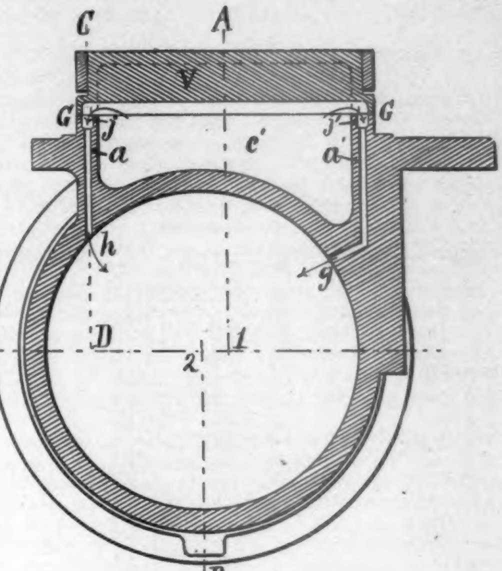


Fig. 2.

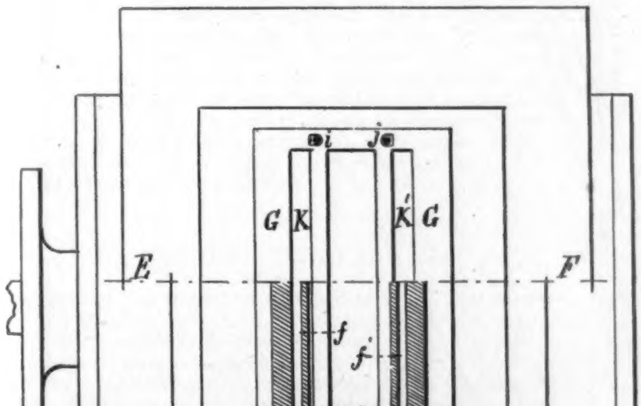


Fig. 3.

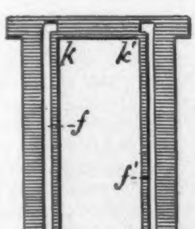


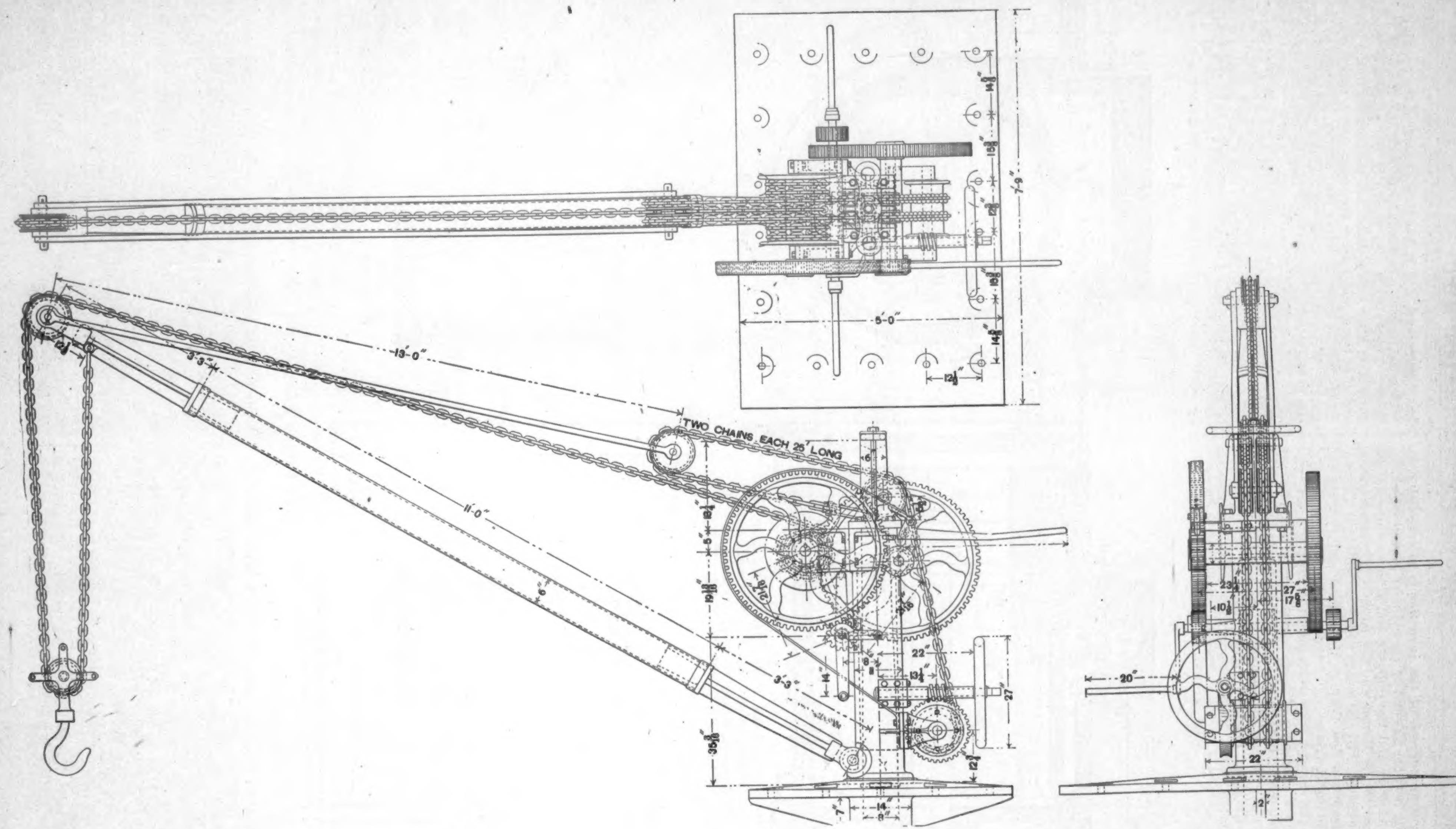
Fig 4

FAY'S ENGINE VALVE.

begins. In order to open communication between these supplementary passages and the main steam passages *c* and *c'*, grooves *f* and *f'* (see fig. 4) are cut in the face of the valve. The openings *i* and *j* of the passages *a* and *b* in the valve-seat *G G* are enlarged somewhat, so that their outer edges are in line, or nearly so, with the inner edges of the steam ports *K K'*, as shown in fig. 3, and the extremities of the grooves *f f'* in the valve face are also enlarged, so that their inner edges conform very closely to the exhaust edges *k l* and *k' l'* of the valve, as shown in fig. 4.

In fig. 1 the piston *P* is supposed to be moving in the direction indicated by the dart *J*, and the direction of the movement of the valve *V* is indicated by the dart *A*. The piston is shown in the position it would occupy soon after compression munication through the passage *c*, with the exhaust cavity *L* in the valve and the exhaust pipe *N*, it is evident that the steam which is compressed in *H* can thus escape to the exhaust pipe, and that the back pressure will thus be relieved in front of the piston. Of course an exactly similar action takes place at the other end of the cylinder when the piston moves in the opposite direction.

This device has been applied to a number of locomotives on the Boston & Albany Railroad, and also to a small experimental stationary engine, and tests have been made with both, which show not only a very material diminution of compression, but indicator diagrams also showed that the expansion line was raised and the back pressure lowered. The reasons for the latter are somewhat obscure. The stationary en-



FIVE-TON CRANE FOR WRECKING CAR. BUILT AT THE SHOPS OF THE PHILADELPHIA & READING RAILROAD, AT READING, PA.

gine was so arranged that the supplementary passages could be opened or closed at pleasure, and experiments showed that when running with a constant load at 302 revolutions per minute the speed was increased to 340 revolutions by opening the supplementary passages. We have no reports of the fuel consumption of engines with and of those without this device. It is in such reports that its ultimate advantage must show itself, if it has any. The extreme simplicity of the arrangement commends it. There is not a single piece added to the engine, but only a few holes. The inventor is Henry R. Fay, whose address is No. 8 Exchange Place, Boston, Mass.

WRECKING CRANE, PHILADELPHIA & READING RAILROAD.

The Philadelphia & Reading Railroad have in service at the Third and Berks streets Station, in Philadelphia, a wrecking crane that is of a very simple construction, and could be easily duplicated by any road desiring to build such a crane and wrecking car for its own use. This crane, or, rather, these cranes and the car were built at the Reading shops of the company. There are two cranes on the car, and they are stepped over the trucks at either end. The car is equipped in the usual manner with holding-down clamps that take hold of the rails at the four corners, and the platform is further steadied by jacks placed on the arch-bars of the trucks directly over the oil-boxes. Nearly the whole space beneath the sills and between the trucks is occupied by a deep tool-box, while extra trucks with a supply of blocking are packed on the platform between the crane-posts. The main body of the jib is made of a piece of 6-in. gas pipe slipped over and riveted to castings at either end that carry the foot of the jib and the hoisting sheave respectively. The jib is raised and lowered by means of a wheel 27 in. in diameter operating a worm that meshes in with a gear, as shown in the engraving of the side elevation. This worm wheel has a pitch diameter of 13$\frac{3}{16}$ in. with a face 2½ in. wide, and has 33 teeth of 1¼-in. pitch. The chain for raising the jib is wound directly on the spool to which the worm gear is keyed, and has a double purchase on the stay as shown. Provision is made for slow and rapid hoisting by throwing the first set of hoisting pinions in or out of gear. Instead of having a brake wheel for lowering, the brake strap is made to act directly upon the teeth of the main gear on the hoisting drum. Although the crane has been in service for some time, there is no apparent wear on the ends of the teeth. The crane has been designed for construction with the minimum amount of pattern work, inasmuch as only two of the kind were wanted. As the principal dimensions are given on the engraving, no recapitulation of them will be necessary. The capacity of the crane is five tons, thus giving the crew the power to hoist a weight of 20,000 lbs. with the two.

THE CRUISER "CINCINNATI."

The cruiser *Cincinnati* is a vessel of 3,100 tons displacement, and in addition to the battery described in a previous number, she carries three torpedo tubes, one in the bow, for fire ahead, and two in the compartment just abaft the engine-rooms, for broadside fire. Just forward of the foremast and abaft the mainmast, on platforms about 10 ft. above the decks, are two 16,000-candle-power search lights. On a line up and down the foremast are the electrical signal lights of the Ardois system. These are for signalling at night. In the space between the forecastle and poop-decks, and on the same level, are the cradles and tracks for carrying the boats, which consist of one steam launch, one sailing launch, four cutters, two whaleboats, and a dingy. A fore-and-aft bridge runs between forecastle and poop, which permits of free communication to both ends of the vessel on this deck. Above the forecastle is the armored conning-tower, inside of which is the steering wheel, compass, engine-room annunciators and speaking-tubes to all parts of the ship. Above the conning-tower is the bridge, upon which are the same fittings as in the conning-tower. The vessel may be steered from four different and independent places—viz., bridge, conning-tower, poop-deck and steering-engine-room under the protective-deck.

On the gun-deck, under the forecastle, are the closets for the crew, ice machine, anchor engine and galley. In the waste amidships are the engine and fire-room, hatches, firemen's wash-room and shower-bath, evaporator and distiller-rooms and engineer's workshop.

Under the poop are the ward-room officers' mess-room and pantry and two staterooms on the port side and four staterooms on the starboard side. Aft of these come the captain's cabins, occupying the entire after part of the space under the poop. The cabins consist of a forward and an after cabin, stateroom, bathroom and pantry. These cabins are furnished handsomely, having upholstered transoms and chairs, beautiful rugs and *portières*, sideboard and polished table. In the pantry, in racks and on hooks, are the silverware and china for the cabin. In bookcases around the forward cabin is the library furnished to the vessel by the Government. This is for the use of the officers, and consists of numerous books of travel, memoirs of officers, histories, ancient and modern, professional works and standard novels. The captain's stateroom is just off the forward cabin, and is furnished with a bunk, wardrobe, bureau, heater and transom. His bath is just off this stateroom. The after cabin is much smaller than the forward cabin, but is fitted in much the same way. In it are the two 1-pdr. rapid-fire guns.

Every part of the cabins and other officers' quarters is finished in polished hard wood.

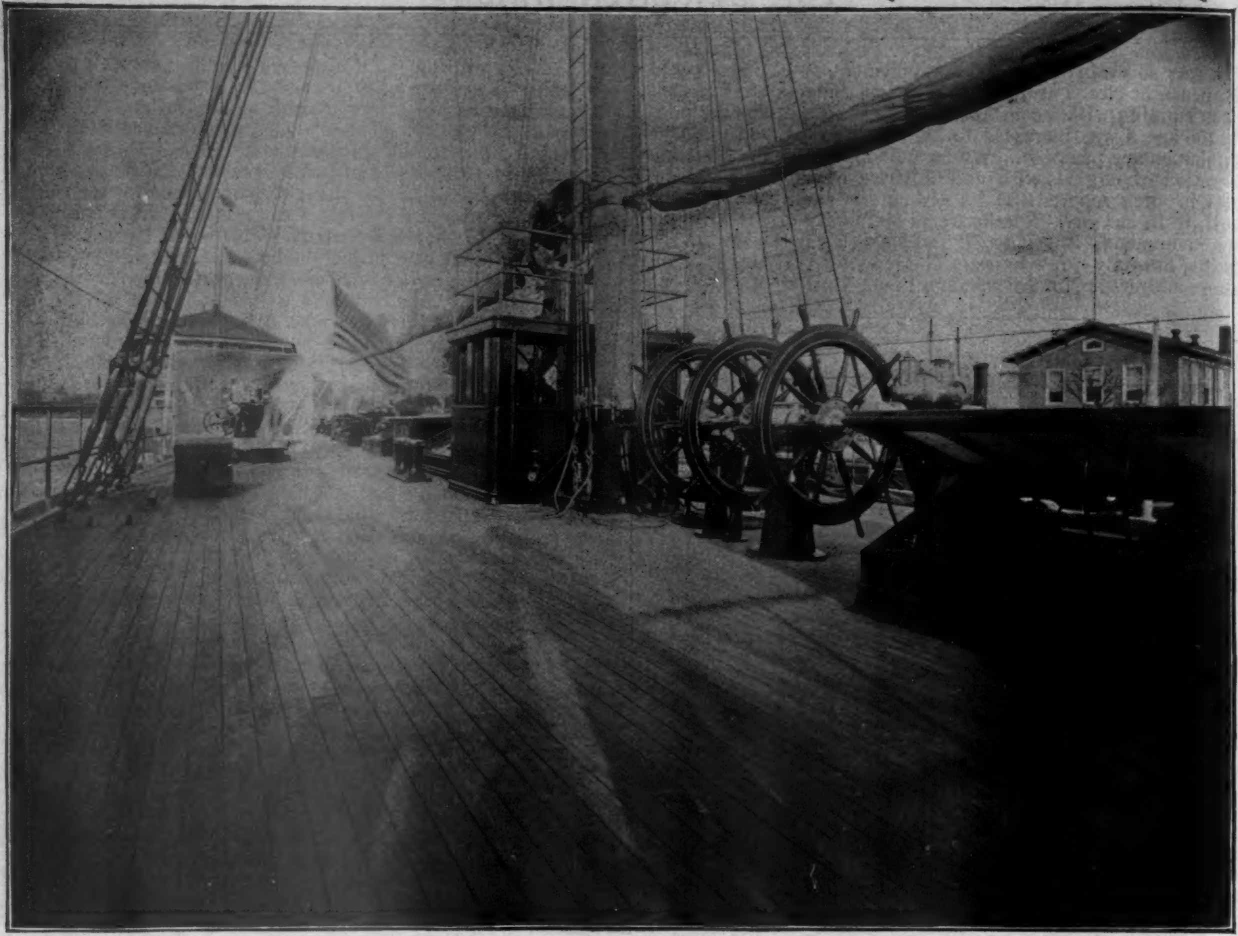
On the berth-deck forward is the bow torpedo tube, sick bay and dispensary with closet and bath for same. Aft of these is the berthing space for the crew, together with the prison. Two passages, one on each side, run fore and aft over the boilers, coming into one passage over the engines, and continuing aft, allowing free communication fore and aft on this deck. Outboard of these passages and over the protective-deck are coal bunkers extending up to the under side of the gun-deck. On the slope of the protective-deck outboard is a cofferdam of cellulose as a protection from shot. In the compartment just aft of the engine-rooms is a torpedo-room having one broadside torpedo-tube on each side, together with their training tracks and gear and racks for stowing torpedoes. In this compartment are also the paymaster's and engineer's offices, the remaining space being used as berthing space for the crew.

In the next compartment abaft the torpedo-room is the junior officers' mess-room on the starboard side, and the warrant officers' mess and staterooms on the port side. In the next compartment aft are the officers' staterooms, the two forward rooms being fitted with two bunks each for junior officers, and the other rooms with single bunks for ward-room officers. In the next compartment aft are two bathrooms and four closets for officers; and the next compartment, which is in the extreme after end of the vessel on this deck, is used as a cabin storeroom. Below the berth-deck is the steel protective, running the entire length of the vessel and sloping down below the water-line at the bow, stern and sides. Over the engines and boilers, and inside the two smoke pipes, heavy steel gratings, called armor gratings, are fitted instead of the solid steel deck. This is done to allow for ventilation in engine and fire rooms, and at the same time protect the machinery and boilers from damage by shot. The protective-deck is 1 in. thick on the top, 2 in. on the side slopes and 1½ in. on the bow and stern slopes. This deck, together with the coal, protects the vitals of the vessel—viz., engines, boilers, magazines, shell-rooms, dynamos and steering engine.

Below the protective-deck, forward and aft of the engine and fire-room compartments, are short decks called the platform-decks. On the forward platform deck are the electrical, torpedo, paymaster's, ordnance and construction storerooms, dynamos and appliances. On the after platform-deck are paymaster's and engineer's storerooms and the steam steering engine and steering wheel.

Below the platform-deck is the hold, which runs as the platform-deck, from fire-room compartments forward and from engine-room compartments aft. On the bow of the vessel on this deck is the forward trimming tank; aft of this come the wet provision storeroom, then the magazines and shell-rooms, which latter, in addition to being below the water-line and under protective-deck, are protected by coal on the outboard sides. The after hold has the after magazines and shell-rooms, engineer and ward-room storerooms, and in the extreme after end the stern trimming tank. Each engine-room is a water-tight compartment in itself, a fore-and-aft bulkhead running between them, extending from inner bottom to under side of gun-deck. A fore-and-aft passage runs between the boilers, having a bulkhead on either side extending from inner bottom to gun-deck, and over the middle boilers passes a thwartship bulkhead, thus dividing the boiler space into four separate water-tight compartments. At the forward end of the forward boilers is a thwartship coal bunker, running the entire width of the ship, thus affording additional protection in case of a shot coming in the bow and passing aft.

Below the engine and fire-rooms and fore-and-after holds are the inner and outer bottoms, the space between being divided into separate water-tight compartments by means of the keelson running fore and aft and some of the frames of the ship



The Poop-Deck, Looking Aft.

The Captain's Cabin, Looking Aft.

VIEWS ON BOARD THE U. S. CRUISER "CINCINNATI."

(Photographed by Hart, Brooklyn, N. Y.)

THE GUN DECK, STARBOARD SIDE, LOOKING FORWARD.

THE PORT-SIDE TORPEDO ROOM, LOOKING FORWARD.

VIEWS ON BOARD THE U. S. CRUISER "CINCINNATI."

(Photographed by Hart, Brooklyn, N. Y.)

being built solid. Water-tight manholes and plates are fitted to allow communication with all parts of the double bottoms. The efficiency of these double bottoms was clearly proven during the recent accident to this vessel by striking a sunken wreck near Hell Gate. The outer bottom was pierced in many places, flooding the double-bottom compartments, but the inner bottom remained intact, thus saving the vessel.

Into all the compartments are run suctions to the drainage system, so that any compartment may be pumped out at any time, and by closing the water-tight doors, only one or two compartments will be flooded in case of accident.

The magazines and shell-rooms are fitted with flooding cocks, which allow of these compartments being flooded from the sea at a moment's notice. A complete fire main runs the entire length of the vessel, having nozzles on all decks for use in case of fire, and hose reels are located as near the nozzles as possible. There is also a complete ventilating system throughout the ship, the ducts running from the ventilators fore and aft, having nozzles in each compartment and stateroom.

Coal is carried in the bunkers on the outboard sides of the engine, fire-room and magazine compartments, and extends from the inner bottom up to the under side of the gun-deck, being both above and below the protective-deck. There are 12 bunkers above the protective-deck with a capacity of 262 tons and 18 below with a capacity of 196 tons. In addition 10 tons may be carried in bags and stowed below, making a total capacity of 468 tons. This could be brought up to 500 tons by stowing some in bags on deck without interfering with the management of the ship. The electrical plant is complete in every respect; in addition to the stationary incandescent lights there are numerous portable lights for use in remote parts of the vessel.

Taking everything into consideration, the *Cincinnati* is one of our best-equipped, most formidable and fastest cruisers.

TESTS OF THE PNEUMATIC GUNS.

IN our issue for September, 1894, we illustrated and described the pneumatic dynamite guns that have been placed at Sandy Hook for the protection of the channels entering New York Harbor. Our readers will remember that this battery consists of one 8-in. and two 15-in. guns, built by the Pneumatic Torpedo & Construction Company. For the details of the arrangement and construction of the battery we refer to our previous article.

As the guns were built under a contract with the Government, wherein the latter assumed no responsibility except to pay for the guns, provided they fulfilled the requirements of the agreement, it was of the utmost importance that the performance of the guns should be such that the most exacting board could find nothing to criticise. The testing of these guns had been carried on for some time under the auspices of the company's officers, and an elaborate system of records preserved showing the fall in pressure in the air cylinders for various air and service charges, the former corresponding to blank cartridges in the ordinary rifle. After a long series of such trials, in which the setting of the valve was carefully observed for ranges and action, the official acceptance test was made.

The endurance test of the whole plant was, as given in our previous account, 50 rounds in the first hour, 20 being from the 8 in. gun and 15 from each of the two 15 in.; then, for the next two hours, 30 rounds per hour. These were merely "air shots," but the valve was set for extreme range. The results of this excessive trial, that far exceeded anything the battery could ever be called upon to meet in service, were that 50 shots were fired in the first hour, 33 in the second and 36 in the third. The initial air pressure at the firing of the first shot was 1,008 lbs. per square inch, and though this was not exceeded at any time during the trial, it was touched at several times during the second and third hours. The lowest point touched by the pressure was 930 lbs., at which the sixth shot in the third hour was fired. It may be roughly stated that a firing pressure of 1,000 lbs. was maintained throughout, and no shot, with the single exception of the one mentioned, was fired at less than 990 lbs.

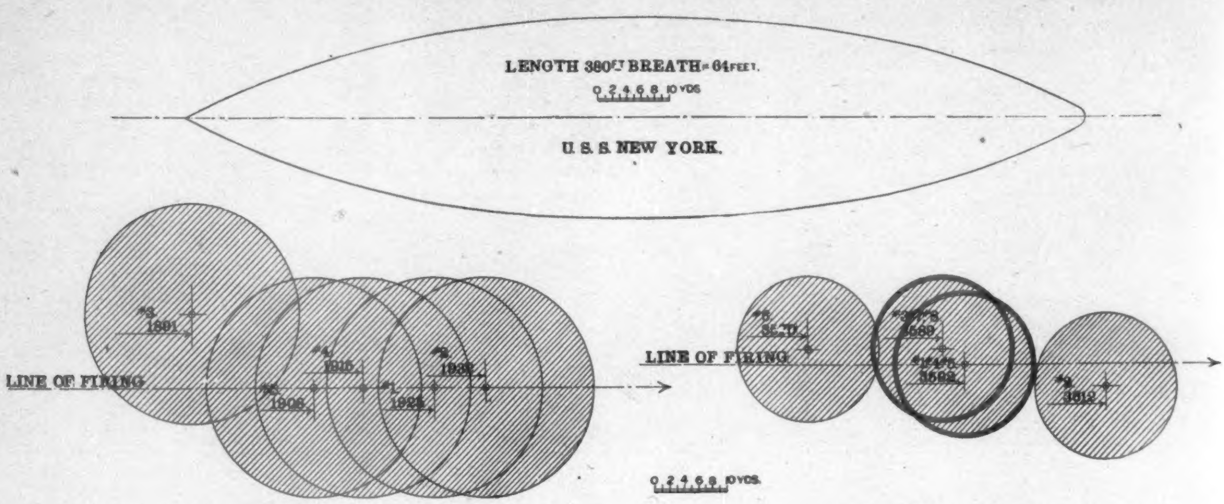


Fig. 1.

PLOTTING OF SHOTS FROM 15-IN. GUN WITH FULL CALIBRE PROJECTILES AND 500 LBS. OF EXPLOSIVE.

Fig. 2.

PLOTTING OF SHOTS FROM 15-IN. GUN WITH 10-IN. SUB-CALIBRE PROJECTILES AND 200 LBS. OF EXPLOSIVE.

PLOTTING OF SHOTS FROM PNEUMATIC DYNAMITE GUNS AT SANDY HOOK, N. J.

We have mentioned this endurance test first because it depended upon the machinery of the steam plant for its execution, although it was the last on the list.

The development of the pneumatic gun—for it has been a case of development—started with the fundamental idea of throwing a charge of dynamite with compressed air; and it having been demonstrated that this could be done, it became necessary to so control the admission of the air that the shot could be fired accurately, for it would be of little use in hurling dynamite about unless there is some probability of its striking the object at which it is aimed, and at this point the development of the gun came in as exemplified by the wonderful valve designed by Captain Rapieff.

It is useless to deny that the original guns were inaccurate, but this does not hold good of the present battery at Sandy Hook. Through the courtesy of the company, we are enabled to give diagrams of the targets of three sets of these shots. The striking point of the shots was located by means of plane tables. For the shorter ranges there were two observers stationed on either side of the battery, at distances of 596 yds. to the right and 627 yds. to the left; while, for the longer ranges, there was a third observer on the Romer Shoals beacon, which stood off from the line of firing at an angle of 17° 19' and a distance of 5,150 yds.

It would be uninteresting to our readers to recapitulate the results obtained by each shot, and we therefore confine ourselves to the sets that are here plotted. In fig. 4 it will be observed that there is a plotting of the zones of danger to a first-class armored vessel due to the explosion of 500 lbs., 200 lbs. and 100 lbs. of high explosive respectively, as plotted from the formula of General Abbot. The plotting of the three sets of shots is done on this same scale.

Referring to fig. 1, which represents the plotting of five shots fired from the 15-in. gun with 500 lbs. of explosive in

each shot. The specifications required that 74 per cent. of these shots should fall within the area of a rectangle 120 yds. long and 30 yds. wide. As a matter of fact, the whole five fell within a rectangle 41 yds. long and 10 yds. wide, while four out of the five fell on the line of fire. Fig. 2 is the similar plotting, eight shots containing 200 lbs. of explosive that fell within a rectangle 42 yds. long and 5 yds. wide, whereas the specifications only required that 54½ per cent. should fall within a rectangle 120 yds. long and 30 yds. wide. This fig. 2 represents the extreme contract range, and the figures appended to the striking point of each shot indicate the distance from the battery at which it struck the water. Fig. 3 is a similar plotting of shots containing 100 lbs. of explosive fired from the 8-in. gun, and shows that the five shots fell within a rectangle 57 yds. long and 3¾ yds. wide,* while the specification target was 120 yds. long and 30 yds. wide, with 66 per cent. hits required. We may therefore safely conclude that the accuracy of fire of these guns stands at a high point.

In our September issue we stated that these guns "command the whole southern approach to New York Harbor." An actual plotting of the ranges shows that the 15-in. guns can throw 200-lbs. charges to any point along the main channel for a distance of about 9,000 yds., and for 4,200 yds. through the swash channel. If a vessel were to enter the harbor at a speed of 20 miles per hour, it would, therefore, be exposed to the fire of the 15-in. guns with 200-lbs. charges for 16 minutes if it were running the main channel and 7½ minutes if it were in the swash channel. In the first case the two guns could throw 20 projectiles, and in the latter 10 projectiles. Further, the guns are capable of throwing 500-lbs. projectiles to any point for a distance of 4,300 yds. along the main channel, and could fire eight projectiles at a vessel running 20 miles an hour before it was out of range, but could not reach the swash channel. This rate of firing cannot even be approached by the rifled guns, while there is nothing in the shape of a torpedo-thrower that can possibly be compared with this performance.

The acceptance tests also included an examination into the time required for the mechanical operation of the guns, such as elevating, depressing, and traversing. The guns can be operated by hand or by electric motors. The latter will carry them through 360° in 48½ seconds for the 15-in. guns, and 1 minute 25½ seconds for the 8-in. guns, while the same work can be done by hand in 8 minutes 11 seconds and 5 minutes 56 seconds respectively. The electric motor will elevate the 8-in gun from 0° to 35° in 14 seconds and depress it in 15 seconds; the elevation and depression of the 15-in. gun to 34½° in 8½ seconds and 9½ seconds; hand-power requiring 45 seconds and 48 seconds for the 8-in. and 26½ seconds and 26 seconds respectively.

One of the prime elements in the success of a dynamite gun is to have a suitable fuse. In regard to this we can only say at this time that out of all the shots fired—and there were 38 official and 8 extra for the company's exhibition—only two failed to explode on impact, and some were fired at the close range of 100 yds. In a future issue we will illustrate this fuse and then give a further account of its action in these tests.

The trials demonstrated that this battery has exceeded the demands of the specifications in almost every particular, and it has therefore been accepted by the Government. The company are now at work upon the battery that is to be located in the harbor of San Francisco, thus giving to the main Atlantic and Pacific harbors of the United States the most efficient type of torpedo-throwing battery.

* Owing to a mistake in the drawing room, the distance of shot No. 1 should be 2578 yds. instead of 2518 yds. as marked. The scale of the plotting is correct.

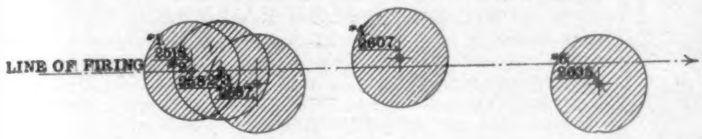


Fig. 3.

PLOTTING OF SHOTS FROM 8-IN. PNEUMATIC DYNAMITE GUN WITH 100 LBS. OF EXPLOSIVE.

THE HEILMANN LOCOMOTIVE.

AT a recent meeting of the American Institute of Electrical Engineers, Mr. H. Ward Leonard read a paper on Recent Electrical Engineering Developments in France and England, in the course of which he referred to the Heilmann locomotive. As his remarks and opinions on this subject are interesting, and may, perhaps, be taken to represent the position of the promoters of this electrical locomotive, we reproduce that portion of his paper in full:

"In France I examined what I considered the most important electrical engineering development of all that I saw. It was the Heilmann electric locomotive. Having been for some years past a firm believer in the merit of this machine, and having been in correspondence with Mr. Brown, Mr. Heilmann's electrical engineer, as to an invention of mine used in this locomotive for the first time on a large scale, I was especially interested in it, and my hearers will please discount as they may think necessary my description of the advantages of a locomotive using my system of control.

"The locomotive I saw was the first one built, and was not in service when I was there. It had run 2,200 miles commercially, however, and as a result of the performance of this first locomotive, which was 600 H.P., there are now building two locomotives of 1,500 H.P. each, which it is expected will go into commercial service about June next.

"This electric locomotive carries its own central station with it. It is really a complete central station on wheels, with its power used for propelling itself. Speaking from memory, I should say the length over all was about 50 ft. The locomotive is mounted upon two bogies each having four axles, so that the weight of the locomotive is borne by 16 wheels, each of which is about 45 in. in diameter. A platform made of heavy iron girders runs the whole length of the locomotive, and is supported upon two pivots, one at the centre of each bogie. Upon this platform is mounted the coal, water, boiler, engine, dynamo, etc., so that it will be noticed every pound of material is used upon the drivers, and therefore becomes effective for tractive purposes.

"The entire weight of the locomotive is 114 long tons—that is, about 15,500 lbs. per driving-wheel, which is about the same as our standard practice in this country. With a tractive coefficient of .2 this means a draw-bar pull of 50,000 lbs., and assuming friction at 6 lbs. per ton, we find that 50,000 draw-bar pull would enable us to pull 1,900 tons on a 1-per cent. grade at a low speed, say 15 miles per hour, and would give us ample draw-bar pull for handling a 200-ton train at any speed thus far seriously discussed.

"Most engineers who have heard of the Heilmann locomotive have derisively dismissed it from their minds as a ridiculous monstrosity of a crazy Frenchman; but I have for some time believed, and am now convinced, that you will in the immediate future be bound to give this machine the most respectful consideration. I find that the impression prevails generally that the modern steam locomotive is really a very perfect and efficient machine. This I think is far from being true. The efficiency of a boiler depends largely upon how perfect the combustion is, and with forced draft we can realize an efficiency of 80 per cent. with very perfectly designed boilers, provided we do not attempt to burn more than about 40 lbs. of coal per square foot of grate surface per hour. But the

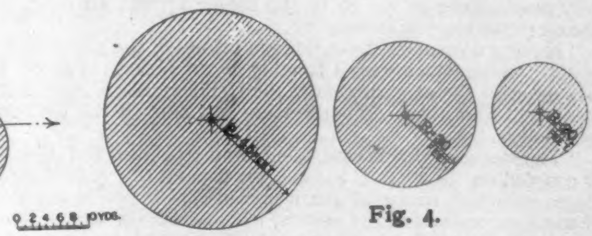


Fig. 4.

15-IN. FULL CALIBRE PROJECTILE WITH 500 LBS. OF HIGH EXPLOSIVE. 10-IN. SUB-CALIBRE PROJECTILE WITH 200 LBS. OF HIGH EXPLOSIVE. 8-IN. PROJECTILE WITH 100 LBS. OF HIGH EXPLOSIVE.

ZONES OF DANGER TO FIRST-CLASS ARMORED VESSEL, BY FORMULA OF GEN. ABBOT.

maximum duty of boilers in locomotive practice such as for the highest speed service involves the use of nearly 200 lbs. of coal per square foot of grate surface, and I need hardly say that forcing the boiler in this way results in a terrible inefficiency. To produce an I.H.P. in a steam locomotive at highest speeds to-day probably requires at least twice as much coal as is required in first-class stationary or marine boilers. This is the first place where Mr. Heilmann is able to show an economy; he is able to carry a larger boiler, and hence does not have to crowd it to such a wasteful point.

"But regardless of an abundant supply of steam from the boiler we find ourselves greatly limited in power for steam locomotive practice at high speed, because of the wire-drawing of the steam and difficulty of properly exhausting when we run our locomotive at its highest speed. The maximum draw-bar pull obtainable when running at the highest speed is only about half that obtainable at slow speed, no matter how much steam we have at command or at what cut-off we work. Heilmann avoids this difficulty, as we shall see presently.

"Another matter of most serious importance is the tremendously destructive effect upon the road-bed and upon the locomotive itself, of the unbalanced vertical component of the motion of the counterbalance weight of the steam locomotive, and also the shouldering effect of the locomotive tending to spread the rails. Probably at least one-third of the cost of maintenance of the road-bed and the locomotive for high speed service could be traced directly to this destructive hammer blow and side thrust. Both of these effects, which become very troublesome as we go to the higher speeds, are entirely absent in the electric locomotive.

"Having now pointed out the weaknesses of the steam locomotive, which develop most forcibly as we increase in speed, I will describe the construction of the Heilmann locomotive and point out how those difficulties are obviated by the electric locomotive.

"The steam engine is compound, well balanced, and directly coupled on its shaft is the electric generator. A four-pole single reduction motor of the iron-clad type is geared to each of the eight axles, and the motors, which are series wound, are multiple with each other across the brushes of the generator armature. As the motor field must have a fair degree of saturation to prevent sparking when the locomotive is running light and pulling no train, it will be evident that under all operating conditions the motor fields are constant and fully saturated, which makes them entirely sparkless. The field of the generator is separately excited by means of a small auxiliary engine and constant potential dynamo, which also supplies the electric lights needed. The engine has a fixed cut-off at the most economical point, say one-quarter stroke, and its speed is adjusted by the throttle.

"The engine in practice is varied in speed from perhaps 50 to 500 revolutions, and the strength of the generator field from zero to its maximum strength. It will be noticed that all steam used is used expansively at a fixed cut-off, and Mr. Heilmann lays great stress on this, although I myself would prefer an automatic engine running at a constant speed, and I believe that he would, if he could get as good ones abroad as we can in this country. For starting, an almost unlimited torque is secured by gradually increasing the generator field strength and speed, which sends a current through the motors, rising smoothly from zero to that current sufficient to start the motor armature. If we leave the field controller and throttle in this initial position, our train will start smoothly, and will continue to move slowly, using the full current, but producing the current with about 50 volts or one-tenth of the full voltage, and we will be producing this power, about one-tenth of that required at full speed, by a steam engine using steam expansively instead of, as in the steam locomotive, full stroke. But of course we desire to accelerate the train rapidly, so we keep on manipulating the field controller and throttle, until we finally have the engine driving the generator at full speed in a field of full strength; which will of course represent the full power of the locomotive. When we reach a grade requiring three times the torque required on the level, we weaken the field to one-third of its full strength. We will then move up the grade at about one-third of the speed on the level while using the same power as was required on the level.

"It will be noticed that under the electrical arrangement on this locomotive, the electric energy is used in such a manner that its voltage is varied in proportion to the speed desired, and the amperes are in proportion to the torque required, so that the electrical energy produced is utilized in the most efficient manner possible.

"Since this method of control of mine has been repeatedly criticised before this Institute on the score that a generator of such size and type when used as described would spark disastrously, I beg leave to say that I scrutinized most carefully the commutator of the generator which had supplied the current during the locomotive's 2,200 miles service, and I never saw a commutator and brushes in more perfect condition, and the engineer assured me that under no circumstances had there been any sparking whatever. I regret that my method of control does not fit the generally accepted self-induction theory of sparking, but am forced to conclude that as something is evidently wrong, it must be the theory, which fails to agree with the facts.

"An electric locomotive of this kind would probably cost for the first few about $30,000, each being equipped with a 1,500-H.P. boiler of our best marine type, and one of our best automatic cut-off compound engines directly coupled to a modern multipolar generator. I believe that a locomotive of this type could be built which would be able to pull 50 per cent. more weight than any of the present steam locomotives, and that it could pull the same weight at 50 per cent. higher speed. I think this type of electric locomotive is the stepping stone between the steam locomotive and the electric locomotive operated from a distant central station.

"To properly try the experiment of operating a high-speed locomotive of 1,500 H.P. from a central station would undoubtedly cost nearly a million dollars. To try it with a locomotive of the Heilmann type would cost not more than $50,000, and if it proves successful, it is not much of a step to replace the boiler and constant speed steam engine with the moving contact and constant-speed electric motor for driving the generator already tested and proven satisfactory."

YARD ARRANGEMENTS ALONG HEAVY-TRAFFIC HIGH-SPEED RAILROADS.*

By A. Flamache.

(*Continued from page 118.*)

INTERMEDIATE STATIONS.

The service that must be assured may be included under four heads: 1. The standing of trains at the station. 2. The side-tracking of slow trains. 3. The reception and storing of freight cars. 4. The passing from one track to another.

Since there is no headhouse and a direct entrance, it is necessary that freight and passenger trains should stand on the main tracks at intermediate stations. The thing to be aimed at, then, is to cut the time thus occupied down to the lowest possible limit. For passenger trains, the length of the stop depends, for the most part, on the time required for getting the passengers in and out of the cars; and this can be considerably lessened by having a suitable arrangement of platforms. The use of elevated platforms that have sufficient length and which give free access to the cars without necessitating the performance of feats in gymnastics, where a single unskilful performer will occasion considerable delay is, I believe, the best way in which to attain this object.

The addition of sheds affording a comfortable shelter, which will attract passengers to the platform, instead of remaining in the waiting-rooms, and the use of bridges and underground passageways permitting the tracks to be crossed in safety at all times, will also contribute very materially to the rapid and efficacious performance of station duties. To these measures for the promotion of the efficacy of the service, others may be added that do not really belong to the subject that we are considering, but which may be enumerated to advantage. The doing away with the immense suburban trains and substituting for them a greater number of short, light trains with a large seating capacity, the use of powerful locomotives that can start the train quickly, quick-acting brakes that will bring the train gently to a stop, cars with separate compartments having easily opened doors which can be operated from the inside, a *personnel* that is active and attentive to business, and finally a public that is drilled into the recognition of the value of time, are the measures that would cause the blocking of main lines by slow passenger trains to almost entirely disappear.

Freight trains that stop at a station to take on or set off cars sometimes stand there for a long time. Side-tracking by backing in is so slow an operation that it cannot be counted upon to free the main line. It is necessary, then, to encroach upon the local tracks in order to lessen the time of standing.

* Bulletin de la Commission Internationale du Congrès des Chemins de fer.

However scanty the local traffic may be, and however short the period of the year during which it lasts, it is always well to treat the freight yard liberally. Do not block it up with cars that must be pushed out to give place, do not run down the tracks for an unnecessary distance, are some of the general instructions that it is well to give.

If the standing of a train is due to the occupation of the following block, it will be necessary to examine into the causes and to do away with them if possible. If this cannot

FIG. 2.

FIG. 3.

FIG. 4.

be done, then it will be well to cut the succeeding block in two, which will facilitate the starting of the second train. Or, in certain difficult cases, one may even be led to urge the doubling of the tracks for a certain distance.

Side-tracking of Slow Trains.—This side-tracking is often made on a single track for both directions. The arrangement in actual use at the intermediate stations of the Belgian State Railway (fig. 5) is laid out in this way. The great disadvantage of this plan lies in the fact that a train arriving by the track A is compelled to cross the track B at T, which naturally involves the stopping of traffic on that line (fig. 2). If the sidings are doubled, as shown in fig. 3, this disadvantage is entirely done away with; a crossing being avoided, there is a saving in signal apparatus. Finally, the two switches c and c' are not necessarily at fixed distances from each other, the expense over the arrangement shown in fig. 2; but these sidings that are used but little can be laid with material that is worn out, simply keeping the first few yards that are used by passenger trains in good condition. They can end in a simple buffer made of old ties.

The Loading and Unloading of Freight Cars require that there shall be suitable platforms along the tracks, long approachable tracks, and various appurtenances, such as cranes, etc. The whole may be embraced under the comprehensive term of the "freight yard." It is most frequently placed on one side of the main tracks. It is only under rare local conditions that it is possible to give each line of rails its own yard.

The length of the freight yard is determined by the importance of the local traffic, and this with the necessary adjuncts should not be made too long. It is better to lay a greater number of tracks for the little extra ground that they will occupy. At any rate, it is well to acquire all of the ground that will be demanded in order to make the extensions that may be called for.

A freight yard frequently consists of two tracks that are parallel or slightly divergent, running into the main lines at two points. It is a common thing to connect them by several batteries of turn-tables. This latter adjunct is usually expensive, cumbersome, and is of no great use.

The arrangement of stations frequently adopted on the Belgian State Railway is shown in fig. 5; it is very good, with the exception of the addition of the two turn-tables, which could be done away with, if we reserve track M for the use of the line A, and the track M' for that of B (fig. 4). Fig. 4 shows how, in case of a double siding, the connection c d, which leads off to the siding for B, also connects with the freight track for the same line. At the same time, the arrangements of the two connections c d and a b permit of the passage from one main track to the other in case of an accidental obstruction. The arrangement shown in fig. 6, which is on the scale of $\frac{1}{4000}$, is a very convenient one. It is the one that requires the fewest changes in the track, and has only one crossing on the main line. The switches c c' can be placed near the freight depot, and the sidings lengthened at will. In many

FIG. 5. PLAN OF INTERMEDIATE STATIONS ON THE BELGIAN STATE RAILWAY

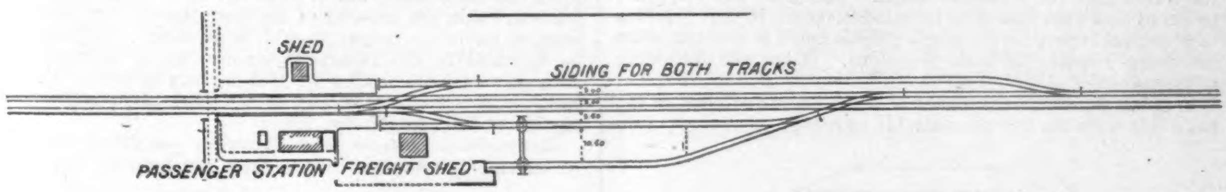


FIG. 6 PROPOSED PLAN OF INTERMEDIAT STATION FOR A MAIN LINE

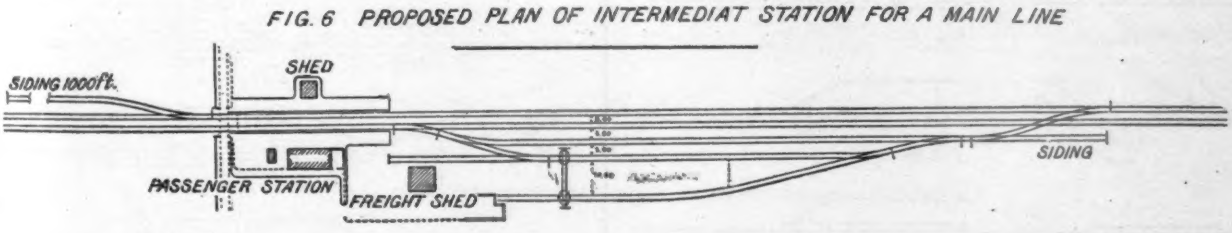
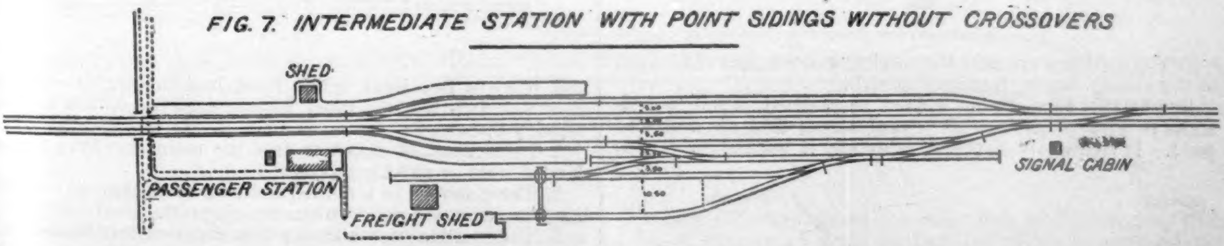


FIG. 7. INTERMEDIATE STATION WITH POINT SIDINGS WITHOUT CROSSOVERS



which will give some advantage from the standpoint of service and safety. Thus there is an advantage in placing them as near as possible to the receiving depot, in order that the station master may be in a position to know that the train to be side-tracked has passed upon the siding so far that it does not obstruct the main line. By placing the signal levers near at hand the station master can assure himself, at a glance, that everything is all right.

In order to secure perfect protection, the length of each siding should be at least from 15 to 20 per cent. longer than the longest train that runs over the road, which will double cases, however, as we shall see later on, it is impossible to obtain this simplicity, and it is necessary to have separate switches for the yard and the depot tracks. We often find, at some intermediate stations, that there is a direct connection between the two main lines. This arrangement, which is common in England, permits the switching of a train from one track off on to the other; it is very advantageous at times, but can only be justified when the tracks are overburdened. Under other circumstances these direct connections simply serve to facilitate the passing from one track to the other in case the traffic is accidentally blocked. Now, it is not reason-

able to establish a cause of permanent danger in order to facilitate a possible movement. It is, therefore, best to do away with all connections of this kind that can be avoided.

General Arrangement of Intermediate Stations.—An examination of the various arrangements that can be employed at intermediate stations, without running counter to the fore-

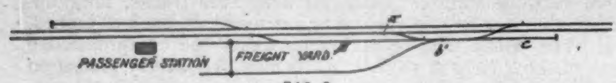


FIG. 8.

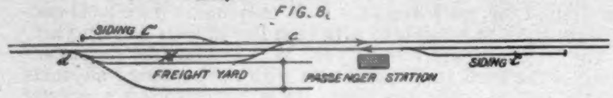


FIG. 9.

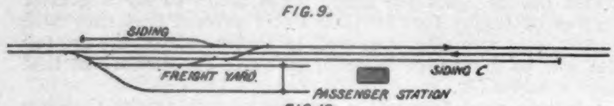


FIG. 10.

FIG. 11.

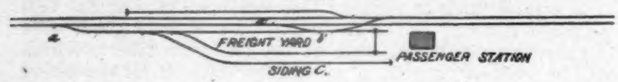


FIG. 12.

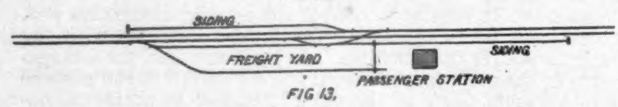


FIG. 13.

FIG. 14.

going recommendations, shows that there is a marked advantage in placing the yard at the right of the freight depot when the trains take the left-hand track. Therefore fig. 6 appears to me to be a plan that is to be recommended, in that it serves as a general type where a single yard is made to accommodate the trains running in both directions. It has the following advantages:

1. It has the smallest number of signals and switches on the main line with the one unavoidable crossing.

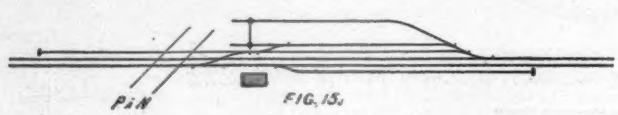


FIG. 15.

FIG. 16.

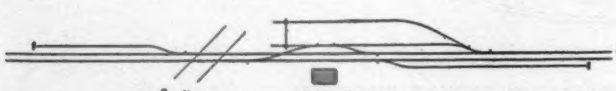


FIG. 17.

2. The switches are near the receiving depot, and the length of the sidings can be increased at will.

But as this type cannot always be realized, it will not be amiss to give plans of other arrangements that are nearly as good. It frequently happens, especially if the freight yard is

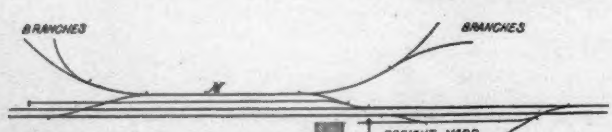


FIG. 18.

already in existence, that the passing siding of figs. 4 and 6 cannot be located between it and the main tracks. The siding *C* therefore is made to be approximately a prolongation of the first track in the yard. It then becomes necessary to put in a supplementary siding, *a' b'*, in order to gain access to the siding *C*, and to pass from one track to the other without disturbing the cars that are stored on the siding *M* (fig. 8).

When the freight yard is placed at the left of the depot, the arrangement becomes similar to that shown in fig. 9. It has one more crossing on the main line. It is well to put in a free track, *M*, between the yard proper and these latter, in order to be able to pass by the switches *c* and *d*, from one track to the other, without disturbing the cars that may be stored on the inside tracks. In some cases the track *M* can be connected to the siding beyond the receiving depot, which will do away with the supplementary crossing (fig. 10). This can also be done by placing the whole siding to the left of the depot, as shown in figs. 11 and 12; but these two arrangements increase, over that shown in fig. 10, the disadvantage of removing the switch *a* to a distance from the direct supervision of the station master. Thus the plan of fig. 13 is to be preferred, although it has a supplementary cross-over. For the same reason the plan of fig. 14 is better than that of fig. 10, although it has the same defect as fig. 13.

FIG. 19.

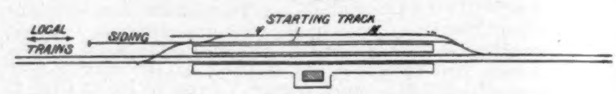


FIG. 20.

FIG. 21.

We have heretofore supposed that the yard is located next to the depot. Although this is common, it is by no means universal. But everything that has been said may be repeated for the arrangements in question. The three figs. 15, 16, and 17 present examples of this type.

Intermediate Stations with Factory Sidings.—If all of the factory sidings are upon one and the same side of the main line, there is usually an advantage in placing the freight yard upon the same side; but if it is not possible to do this, it is necessary that the crossing of the main line by cars pushed by hand or hauled by horses should be avoided. The method to be followed in this case is to connect these factory sidings with one or more tracks *M*, that in turn connects with the main siding on this side, and which thus gives a direct connection to these tracks (fig. 18).

Intermediate Stations with Terminus for Local Trains.—At intermediate stations where there are no point switches at

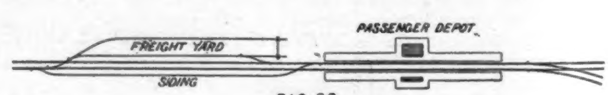


FIG. 22.

FIG. 23.

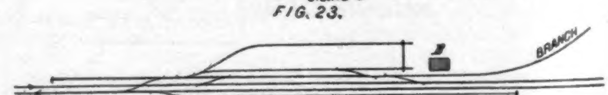


FIG. 24.

the place where local trains must branch off, the arrangements of such stations must be examined in addition to those already discussed:

1. Pains must be taken to free the main line from the unloaded train as quickly as possible.

2. There should be a special starting track that will require no changes in the points when running out.

3. The location of the tracks that are used for the shunting of the engine, in bringing it from one end of the train to the other, turning it, etc., should be such that they do not interfere with the main lines.

These different desiderata can be easily obtained if we place the special starting track on the side of the incoming track of the main line. The two arrangements, shown in figs. 19 and 20, seem to be about the best that can be designed.

On its arrival the local train stops on the main line and discharges its passengers. The engine then immediately backs the train of cars upon the siding *M*, cuts loose and shunts around to the other end by way of the track *N*, and then pushes the train upon the starting track (fig. 19). This

discussion might be prolonged almost indefinitely, but we merely give one other sample of what may be done in fig. 21.

Intermediate Stations with Direct Sidings.—When there are two yards with point switches and sidings into which a train can run without stopping, and they are some distance apart, it may occur that it will be convenient to sidetrack a train at the station that lies between them. As the side-tracking of a train by backing in requires some time to execute, it is sometimes an advantage to allow the train to run slowly and then side-track at the next important station. There is then a great advantage in locating an intermediate station about half-way between the two with point switches allowing trains to run in direct. According to the circumstances of the case, it may be well to either lay four tracks or a third track between the other two.

FIG. 25.

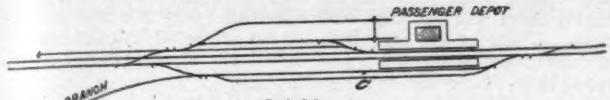


FIG. 26.

FIG. 27.

Direct sidings involve the necessity of having two signal stations for the protection of the lines in each direction. One set of signals can, however, be made to suffice if we take the precaution to locate one end of the siding near the depot, so that all entering trains are under the immediate supervision of the men who are responsible for their safety. This end may then be cut off from the interlocking apparatus.

Thus, while the arrangements of the intermediate station must not differ essentially from the current practice, this use of head-on sidings does possess some advantages that cannot be neglected, and these are:

1. Trains taking on or dropping cars can stand on the sidings and not obstruct the main line in the slightest.

station. The service at such stations, therefore, does not differ from other intermediate stations, and the arrangement of the tracks only differs in that the presence of a junction permits of a location that will be more advantageous to the service. In order to get the advantage of this it is essential that the junction should be within the yard and not at one end of it. The Belgian disposition, which consists of placing the yard upon a common trunk, is not recommended (fig. 22).

In order to obtain a rational arrangement, it is necessary that two cases should be clearly distinguished: 1. That the

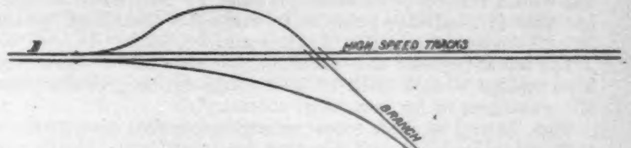


FIG. 28.

FIG. 29.

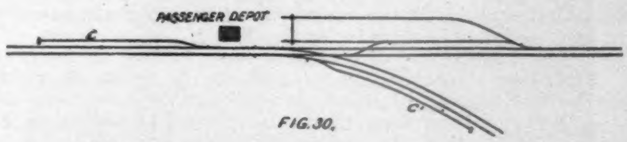


FIG. 30.

FIG. 31.

branch, which is usually of a single track, is only of slight importance. 2. That the branch has a service similar to that of the main line.

In the first case there is an advantage in placing the freight yard at one side of the junction, as shown in fig. 23. The switching of trains from the track B is made upon the siding C', but in many cases this can be done away with and the branch itself be used. It is best to locate the station building just ahead of the junction, so that trains coming from the

JUNCTION STATION WITH UNDERGROUND PASSAGE

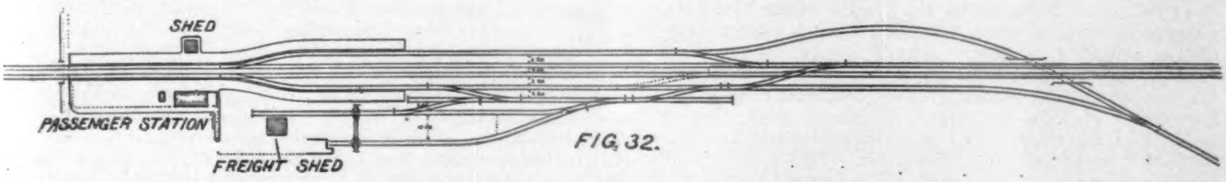


FIG. 32.

JUNCTION STATION WITH UNDERGROUND PASSAGE

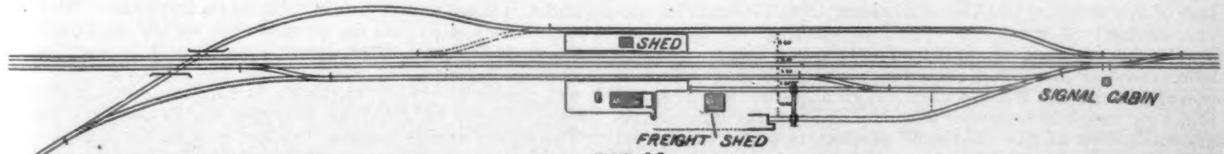


FIG. 33.

2. The head on siding can be used to great advantage by passenger trains that have to go on the side-track to allow a faster train to pass.

3. A main line crossing can be avoided and a better connection substituted therefore by establishing means of communication between the two main lines.

Fig. 5 gives the scheme of a station in which these advantages are realized.

Intermediate Stations with Junctions.—Stations of this kind are those where a branch line comes in to make a connection with the main line, but without there being of necessity facilities for the change of cars by the passengers or handling of freight or cars for transhipment. Oftentimes the trains pass without stopping, the change being made at a more important

branch do not obstruct the main line while standing there; but if the branch is of comparatively little importance, there is no harm in locating the building at B'. It is also possible to avoid the standing of trains that are to run in on the branch on the main lines by placing the switches a a' at c c'. If the freight yard must be placed on the opposite side of the tracks from the station building, the arrangement becomes similar to that shown in fig. 24.

In the two types that have just been shown the branch is located on the same side of the main line as the station building and the local tracks. If this is not the case the connections become a trifle more complicated, but the service is none the less easy. Examples are given in figs. 25, 26, and 27.

It will be remarked that when the branch starts off to the

left of the main line it affords a means of running direct into a siding in the divergent direction, that is when the trains run on the left-hand track. This is shown in figs. 24, 25, and 26. It would be possible to obtain the same advantage when the branch runs off to the right, as shown in fig. 27, by carrying the switches *a a'* to *c c'*, but this switching off to the right would involve the crossing of the main line, which might block it at an inopportune moment; and is one of the causes of danger that materially lessens the advantages of a head-on siding. If these latter are considerable, it will be well to look into the matter and see whether a switch running off to the left would not be preferable. It may be mentioned in passing that it is always possible to carry the branch off to the left by the use of a bridge, as shown in fig. 28.

The advantages of this arrangement are quite evident, and its adoption should only be abandoned for imperative local circumstances or for reasons of economy.

Figs. 32 and 33 show some arrangements that give good results where underground passages are used for the clearing of the main lines. If the two lines at the junction are at all comparable, these plans do not apply, for it is necessary to adhere to the most easily located junction connections.

It is a mistake to locate the place of the local installations upon a single trunk, as is usually done in Belgium, and which is shown in fig. 29. By comparing the plan of fig. 29 with that of fig. 30, the superiority of the latter will be easily seen, and that fig. 31 is better than either.

The side-tracking of diverging trains is done on the main line; that of converging trains on the siding at the right. For the purpose of securing equal facility of service, the freight yard is so placed that it is traversed by but one of the branches, so that the number of signals and the danger of collision are reduced to a minimum. The sidings *c* and *c'* can be done away with by switching the trains running in one direction upon the opposite branch both in the diverging and converging service; but this is only to be advised in the cases that have been supposed—namely, a heavy traffic in both directions. Finally, in some cases a better arrangement than either can be obtained by placing the station in between the two branches and using the cross-over of the junction for the freight yard. The station building should be placed in the angle of the two lines, but it can be kept upon the common trunk if the local service is not too great.

(TO BE CONCLUDED.)

THE ELECTRIC MOTOR IN A BOILER SHOP.

The interest that was taken in the February discussion of the Mechanical Engineers on the Electric Motor in the Machine Shop is sufficient to show that the subject is attracting a great deal of attention, while the actual data available on the subject are very meagre, even the motor builders themselves being unable to state definitely as to just what results from the standpoint of economy can be expected from this or that method of installation. Despite these drawbacks, however, there is a well-established idea pervading the community of mechanical engineers that the electric motor readily lends itself to the driving of machine tools, and its application is rapidly growing.

A short time ago the Cornell Steamboat Company, of Rondout, N. Y., decided to build a new boiler-shop for the repair work on their large fleet of boats. After a careful investigation of the subject, the Chief Engineer, Mr. Thomas Coykendal, decided to use electric motors, making an individual application to each machine. Though one large company recommended the use of one large motor having sufficient power to drive the whole shop through a line or lines of shafting, very much in harmony with the trend of the general recommendations at the February meeting, this was considered to be in no way superior to the use of an engine, and was discarded. The engraving shows the application of a 2½-H.P. motor to the driving of a small drill and emery wheel, which is the only case where one motor drives more than a single tool, and a 5-H.P. motor driving a shears. The smaller motor makes 950 revolutions per minute and the larger 650 revolutions, the speed being reduced by means of counter shafting, as shown, with two exceptions: a combined punch and shears is driven by gearing direct from the motor, and a 7½-H.P. motor is coupled direct to the shaft of the blower for the furnaces and forges. The complete equipment of the shop consists of one 2½-H.P. motor, driving a drill press and emery wheel; one 7½-H.P. motor driving blower; one 2½-H.P. motor driving large drill press; one 5-H.P. motor driving horizontal punch; one 5-H.P. motor driving shears; one 5-H.P. motor driving combined punch and shears, making a total of 27½ H.P. capable of being called into action, or, speaking more accurately, 25 H.P., as the blower only requires 5 H.P. for its operation instead of the 7½ H.P. at which it is rated. It is the intention to put an electric travelling crane into the shop at an early date.

Of the convenience of the arrangement both Mr. Coykendal and Mr. Belcher speak in the highest terms. The tools are always ready for action; though the men may all be out of the shop and at work on board boats, if a hole is to be punched or a piece of iron to be cut, it is simply necessary for a man to go to the shop, start the motor, do his work, shut off the current, and leave matters as he found them. By doing away with shafting and bolting the motors to brackets on the walls, the whole floor space is left free and clear, so that the travelling crane, when it is put in, will have an effective travel nearly from wall to wall, and covering every machine in the shop. Then, as the machines can be arranged independently of each other along the walls, the whole of the central floor space is available for erecting purposes.

But, as these advantages are apparent to all, it remains to ascertain what may be the cost of operating such a plant. The current is obtained direct from the power-house of a street railway company that stands at a distance of 1,650 ft. There is no reduction in the voltage, which is 535; and the Crocker-Wheeler motors are used. This voltage, it will be seen, is very much higher than that recommended by Professor Crocker in February, but is used in order to simplify the installation and the handling of the current. It is estimated that the 7½-H.P. nominal or 5-H.P. actual motor that drives the blower, and the 2½-H.P. motor driving the drill and emery wheel, will be run continuously for 10 hours a day, and that the remainder of the machines are working on an average total of 2½ H.P. per hour for 10 hours a day, making a grand total of 10 H.P. continuous working. This is an estimate, and one not reached by actual metre measurement, but is that upon which the estimate of the cost is based, which is put at $50 per calendar month.

This is a definite statement of cost, and is seemingly satisfactory. While it appears probable to an outsider that the cost of producing 10 H.P. in a boiler-shop, where the services of the engineer could be utilized in work about the shop, might be made to fall below $600 a year, it is hardly probable that that amount could be made to cover the 25 H.P. which would have to be kept on tap, as it were, all of the time, and certainly could not if the engineer became an engineer and nothing else; and any one who has tried it knows how unsatisfactory it is to attempt to utilize the spare moments of an engineer about a shop; and when we compare the dirt and trouble of an engine, the space occupied by shafting, with the convenience of operating, and the bright daylight that is made possible by the perfect freedom from all overhead obstructions, it is very evident that the Cornell Steamboat Company did well in adopting the electric motor for its boiler-shop.

While dealing with this subject, it will be in order to quote from a letter received by Mr. Richmond from M. Melotte, after the presentation of his paper on the Electric Motor in the Machine Shop. This letter is a hearty endorsement of the application of electric motors which we are considering, and is valuable in that it emanates from one who has had a practical experience in this very matter. After referring to a paper by M. Castermans and himself that was published in the *Revue Universelle des Mines*, M. Melotte wrote:

"Since the time of writing that description the shop has been enlarged, and we have been forced, in the first place, to add a Willans engine driving directly a dynamo at 350 revolutions, 300 I.H.P. At the present time we are constructing for the same factory a third dynamo which will be operated by a Willans engine of 360 H.P., indicated at 350 revolutions, which will result in giving to the shops 5,600 ampères at about 125 volts, instead of 2,400, as provided for in the first instance. The reason of this increase lies not only in the enlargement of the factory, but more particularly in the increase of useful work furnished by the workmen operating the machine tools.

"In fact, at the outset the workmen were to produce 150 pieces of each of the constituent parts of the gun. Paying them at piece rate so stimulated their ardor that they succeeded in producing 300 pieces every day—that is to say, doubling the production.

"Thus it comes that the motors are found too small; and here I may make a little digression.

"According to the instructions of the builders of the machine tools, these latter were arranged to have about 12 effective H.P. on each shaft of transmission. As a precaution we had placed electric motors of 16 B.H.P., but it was found a short time after getting to work that these motors were developing 30 H.P. I cite these figures at this time, although only motor No. 5 was in this condition; but a short time afterward

several others came to it, and one could see for four months these motors of 100 ampères working with charges varying from 200 to 300 ampères. You can imagine that they got warm and that they sparked, but they worked nevertheless. At this time several people not initiated in electric science called in question the work done by the motors, saying that the motors only gave out 10 H.P., while we declared that they were doing 30 H.P. We were obliged to make experiments with the brake to convince them. It was then decided to put more motors in, but as the shafts were very long, and had not been provided for this load, it was decided to cut them in the middle and place a motor at each end. We left in place the 16-H.P. motor; at the other end we placed a motor of 35 H.P. This has been done with three or four shafts; for other shafts we were content to replace the 16 H.P. motors with others of 25 H.P. or 30 H.P. Finally, quite recently the factory has enlarged its cartridge room, which necessitates the new motors. I have made this long digression in order to explain to you why the original provision of 2,400 ampères has had to be replaced by 5,600. I have omitted to mention the extension of the electric lighting, which has absorbed from 300 to 400 ampères.

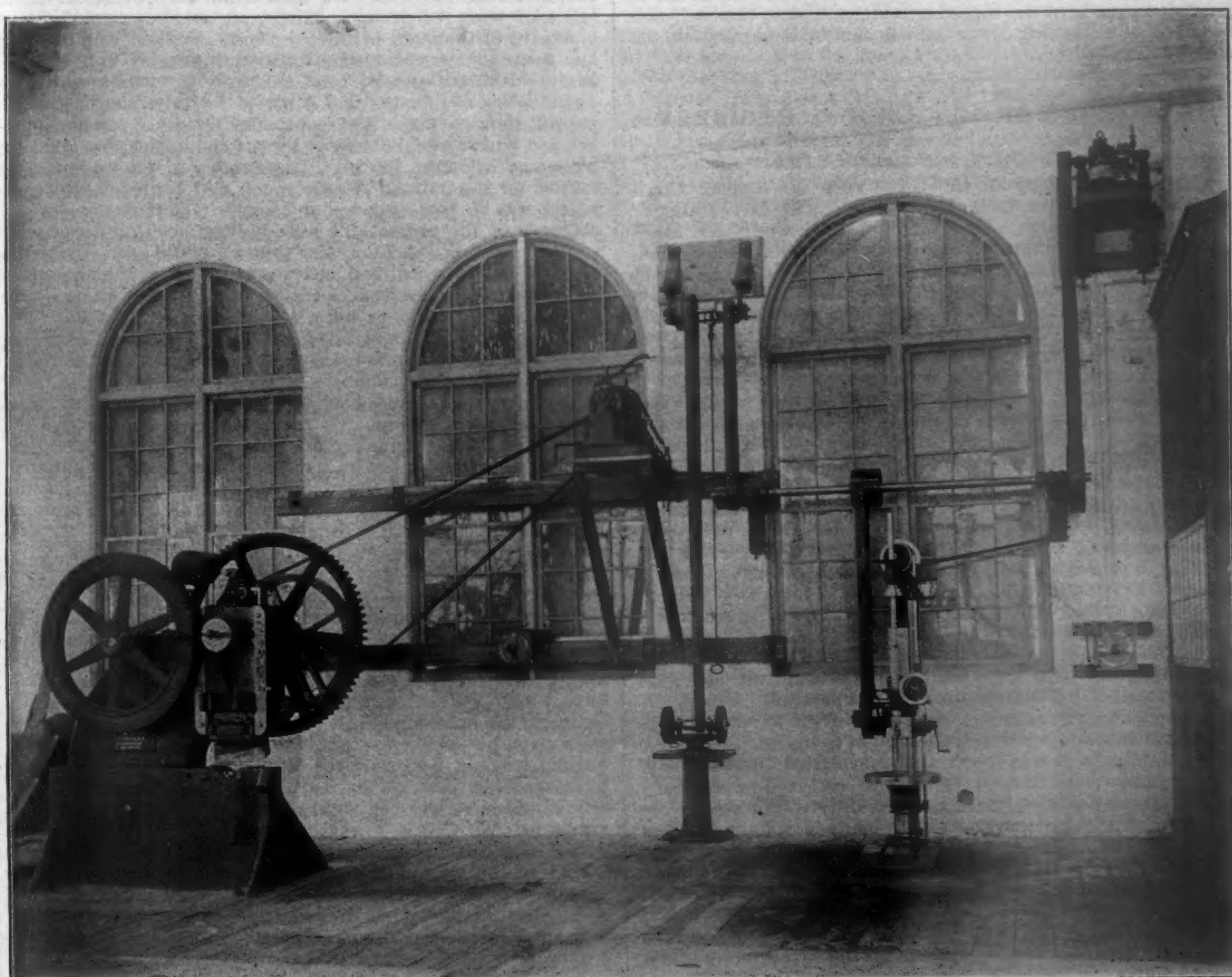
"All that I have just said to you serves to explain the extraordinary elasticity of transmission of force by electricity. You see in what a difficult situation the gun factory would have been if, instead of this mode of transmission, it had adopted mechanical transmission. The difficulty of increasing the transmitted power would have been enormous, and it would have been necessary to remodel the whole. The first difficulty would have been to have had the transmission shaft capable of transmitting the increase of power. It would have probably been necessary to replace them with others proportionate to the work. This difficulty overcome, it would then have been necessary to transmit to them this work right from the engine-room; while with electricity, a piece of wire and a motor, and the whole thing is done!

"Since this installation I have had to calculate, and have constructed other dynamos of the same kind at different speeds and power, going up to 600 H.P., and those of high speed have always given the most satisfaction. Moreover, from the purchaser's point of view, they are altogether preferable, costing less and being more efficient than slow-speed dynamos. I should be in favor of these latter only for very large units—1,000 H.P. to 1,500 H.P.

"As to the direct application of motors to machine tools I would not like to commit myself, not having had sufficiently long experience of this subject.

"My opinion up to the present is that the heavy machine tools, which take 1 H.P. effective, could advantageously be operated by separate motors; but that when it is a question of small lathes or small milling machines the case is not the same. And here we must distinguish between the case where the tools have to work intermittently and where they are constantly occupied—in fact, if it is desired to put a motor to every tool, we should have to with ¼-H.P. motors, of which the efficiency is necessarily very small. If we group three or four of these machines together they could be operated by quite a small countershaft driven by a motor of about 2 H.P., from which one could get an efficiency of 70 to 75 per cent. without paying excessively for it.

"It is also necessary to judge of the probable time which the machines will work every day, and of the curve of efficiency, the different loads of the motor and of the transmission apparatus before deciding in favor of one system over another. "If, for example, you have four milling machines taking ½ H.P. each, and you could be sure of keeping them all going during the day without stopping, you need not hesitate to work them by a 2-H.P. motor and a countershaft; but if it is one of those general machines which are necessary in all shops, such as drilling machines, emery wheels, drill-grinding machines—in other words, tools which are only used from time to time—then I am convinced that a small motor, with its



TOOLS DRIVEN BY ELECTRIC MOTORS IN THE BOILER SHOP OF THE CORNELL STEAMBOAT CO., AT RONDOUT, N. Y.

wretched efficiency, even if it were as low as 40 per cent., would be preferable to no matter what system, for they use no power except when they are running, and then it gives 40 per cent., while, if you are turning a countershaft while the tool is not running, there is a loss of current, and at the end of the day your total efficiency will fall to 10 per cent., or even less.

"I think I have answered your request in going so far into detail; nevertheless, I will add a few words. All that I have just said to you refers only to shops where metal is operated on, such as machine shops. In shops for the current manufacture of some specific article the cost is approximately the same. Thus, at Herstal, where the same pieces were made over and over, it would have been possible to subdivide more than was done the distribution of power. The same is true everywhere. In textile manufactories, in the weaving room, everywhere, indeed, where it is a question of manufacturing stuffs of certain importance, the subdivision should as far as possible be made of the thread machines, looms, the 'self-acting,' etc., constituting units which can be separated in the combination."

THE MEETING OF MECHANICAL ENGINEERS.

RAPID TRANSIT IN LARGE CITIES.

THE March meeting of the New York Mechanical Engineers was held on the 13th of the month, with Mr. George S. Morrison in the chair. Mr. W. B. Parsons, the Chief Engineer of the Rapid Transit Commission, delivered the address, which was almost entirely confined to a brief historical sketch of the rapid transit problem in New York, and the means that have been taken to solve it in large cities abroad, especially London and Liverpool. As no definite plan has as yet been adopted for New York, he said nothing of the proposed system, other than that it was to be an underground route.

In the discussion some matters of interest were brought out relative to the cost of the operation of the elevated lines in New York and Brooklyn, by Mr. Nichols, Chief Engineer of the latter road. In the course of his remarks, he said:

"Perhaps the most striking illustration we have of successful railway operation in the world is that presented by the Manhattan Elevated in New York to day. In looking over some figures the other day, I was rather surprised to see how the working expenses of the London roads compare with those of the Manhattan system in New York, how favorably it compares with it, how much better the working expenses are on the English than on the American line. That may be due to the fact that their expenses for maintenance and the like are so much lighter than they are here. Recently my attention has been called to some figures as to operation, in which it was shown that the essential elements differed very radically. For instance, when we were called upon to discuss the figures by the train mile, it was shown that they varied, outrageously, one might say; and when it came to be analyzed more closely by the ton-mile, it was found that the difference was scarcely appreciable, this comparison being made not only between two prominent American elevated lines, but comparing these also with the Liverpool Overhead line, operated not by steam, as in this country, but by electricity; and, all things considered, it was rather a remarkable uniformity, I think, in the results as given by the figures. It may be interesting to give the figures for the cost of operation of the two principal lines immediately within our notice, the Manhattan Elevated in New York and the Brooklyn Elevated in Brooklyn, the former covering a mileage of about 35 miles, and the latter about 20 miles, speaking now of what is Brooklyn proper, independent of the Kings County line. It appears from these figures that, while per train-mile the operating expenses of the Manhattan Road are about 61 cents, those of the Brooklyn were 38.33 cents. Analyzing that still further, and getting it only approximately as we can by the ton-mile, it comes to this, that the cost on the Manhattan is .615 of a cent, while that in Brooklyn is .572, which is practically the same result. It may be interesting to state that the following percentages are found to be approximately correct, and I give them for the Manhattan, because they do not vary materially, except in one or two points, from the Brooklyn road. The expense of motive power, including all labor and all fuel and handling of fuel and the like, amounts to 34 per cent. of all operating expenses; the repairs to rolling stock are about 12 per cent.; the maintenance of way expenses, 10 per cent.; train expenses, 19 per cent.; station expenses, 15 per cent.; general expenses, about 11 per cent. of the total. Where the maintenance of way on the Manhattan amounts to 10 per cent. of all operating expenses, on the Brooklyn line that maintenance of way amounts to 4 per cent.; so that is the greatest difference there, excepting in motive power. Of course the motive power on the Brooklyn road, instead of being 34 per cent. of all operating expenses, is about 43 per cent."

Mr. M. N. Forney: In 1873 I had the honor to serve on a committee of the Society of Civil Engineers that investigated this subject of rapid transit, and at that time I did a great deal of work, and the committee was very much abused for what it did. However, the present elevated railroads substantially adopted the recommendations made at that time, and in fact the report which was submitted formed to a certain extent the basis of the action which they took thereafter. That report recommended an elevated railroad. We spent considerable time in the effort to arrive at some conclusion as to the probable traffic which an elevated railroad would carry. I remember using all sorts of persuasion to get from the surface railroads a statement of the number of passengers which they were carrying. Sometimes we succeeded and sometimes we did not. We then made a hypothetical calculation of what the probable earnings would be, assuming that one-third of the seats in the car would be filled, and one-half and three-quarters and some other proportions, and then assuming different rates of fare, although we were afraid to go down below five cents; and it would be quite amusing at the present time to take that report and see the extreme apprehension which was manifested by our committee, for fear that we would calculate too high the number of passengers to be carried on the railroad at that time; and probably that committee was in part responsible for the fact that the elevated railroads of the present day were built of so light a character as they are. We did not feel that we could recommend the construction of a railroad heavy enough or strong enough to carry heavy locomotives, because we did not think there would be the traffic to necessitate their use. At that time underground roads were discussed, as they have been ever since, and the conviction arrived at by myself and, I think, nearly all the other members of the committee was in favor of elevated roads; and I am still a believer in elevated roads as against underground. Of course there is the fact that the subject of underground roads has been investigated and studied very thoroughly by the ablest men in the community, and after long and mature deliberation they have come to the conclusion that the thing for New York to do is to build an underground railroad. But my own conviction is that, although it is now too late to reverse the decision of the Rapid Transit Commission, that the thing for the city of New York to have done would have been to buy the right of way for the railroad, and to have retained that right of way and give permission to a railroad company to build its road on that right of way. I have not made any very careful or thorough investigation of that matter, and therefore my opinion cannot have much weight, but my general impression is that by building the structure high enough so as to permit sufficient room to put at least two-story buildings underneath, that those buildings could be leased for a sufficient amount to pay the interest on the cost of the real estate, so that practically the city would have had the right of way free of any cost. Like my friend Mr. Cruise, I have always been in favor of an elevated road. Mr. Cruise has gone a step further, however; instead of being content with a structure underneath the elevated road, and renting that out for workshops and beer saloons and similar moral purposes, he proposes to put a structure up over this—I do not feel safe to say the number of stories; but he would build a tunnel through this structure, and run his elevated road through that. Mr. Cruise should give us his reasons for thinking that that is a practicable scheme. I am sure that I would not deny that it is, and it certainly is worthy of consideration.

The Chairman: The subject of elevated roads through blocks has been one that has been discussed a little, but it has sometimes seemed as if it had not been discussed as much as it should be. The great difficulty, apparently, in the building of a line through the blocks by a private corporation is not so much the doubt whether it will pay, as the fact that it requires an immediate outlay of capital, not only enough to build the structure, but to buy the land; and it is much easier to raise $25,000,000 with the expectation of 6 per cent. interest on it, than it is to raise $50,000,000 with the expectation of 8 per cent. interest on it. There are limits to the amount which can be raised in one lot. There is one point, however, which I think it would be well to bring out in this discussion. When the elevated railroads were first opened they charged 10 cents fare, except for a little while during the busy hours in the morning and evening. They afterward changed to 5-cent fares at all hours. The statement is made, and there is good ground for it, that the 5-cent fare pays exceedingly well as an average, but it would not pay for long-distance travel. Many of the schemes proposed for elevated railroads have been proposed for the purpose of carrying people to the upper end

of Manhattan Island and into the Annexed District. Is not one of the greatest drawbacks that we find now in getting capital to build those lines the fact that fares are limited to 5 cents?

Mr. Parsons: It has been said that the day will come when electricity as a motive power will be more economical than steam. That day has already come. In reference to the comparative operating expenses of the Manhattan and Brooklyn elevated railroads, as compared with the three electrically operated rapid transit roads, the Liverpool Overhead, the Intramural of Chicago, and the City & South London, I have to acknowledge the kindness of the officers of those roads in giving me their figures in getting the coal consumption in pounds independent of dollars and cents. There is no use in comparing the cost of coal in London with the cost of coal in Liverpool or Chicago or New York. These five companies have given me their actual coal consumption, and I have had the figures tabulated and published. They also gave me the weights of their trains, so that, as Mr. Nichols stated, we finally have to get down to the basis of the ton-mile, and I finally reduced the question of the consumption of coal to pounds per ton per mile. These figures are given in decimals of a pound of coal consumed per ton per mile:

On the Liverpool Overhead the consumption is	.416
On the Intramural	.495
City & South London	.604
Manhattan Road (Ninth Avenue), short trains	.609
Brooklyn Elevated, short trains	.661
Manhattan on the big trains	.928
Brooklyn Elevated, big trains	.526

Analyzing the first five figures—it is really unfair to take into account the Manhattan figures at all—the Liverpool Overhead trains weigh 42 tons, the City & South London, 44 tons. Taking the Brooklyn Elevated average train as 63½ tons, we see that the coal consumed on the Liverpool Overhead is .416, and on the Brooklyn Elevated, .661. In other words, the consumption of coal in pounds per ton per mile is but two-thirds of that where they run steam locomotives. In Liverpool they burn slack of the cheapest grade that they can buy. On the Brooklyn road they burn a high-priced anthracite; so reducing it down to the valuation put in dollars and cents, the difference would be far greater than it is when expressed in pounds. That is also regardless of the fact that the Brooklyn elevated trains weighed half as much again as the Liverpool trains, and the coal consumed per ton per mile does not increase in proportion to the weight of the train. Of course there are certain losses which are entirely independent of the weight of the train. The Brooklyn elevated train, which weighs 91½ tons, falls down to .526 and .661. The Manhattan weighs 80 tons, the coal consumption is .609, and rises to .928; so that we see that the coal consumption per pound per ton per mile on an electrically run road is actually less and considerably less than that on roads run by a steam locomotive.

ACCIDENTS TO LOCOMOTIVE ENGINEERS AND FIREMEN.

The object of publishing this monthly list of accidents to locomotive engineers and firemen is to make known the terrible sacrifice of life and limb that is constantly going on among this class of people, with the hope that such publications will in time indicate some of the causes of accidents of this kind, and to help lessen the awful amount of suffering due directly and indirectly to them. If any one will aid us with the information which will help make our list more complete or correct, or who will indicate the causes or the cures for any kind of accidents which occur, they will not only be doing us a great favor, but will be aiding in accomplishing the object of publishing this report, which is to lessen the risk and danger to which the men to whom we intrust our lives are exposed.

The only, or the chief source of information we have, from which our report is made up, is the newspapers. From these the following list of accidents, which occurred in February, has been made up. Of course we cannot report those of which we have no knowledge, and doubtless there are many such.

ACCIDENTS IN FEBRUARY.

Marshall, Tex., February 1.—A train on the New Orleans & Pacific Railroad ran into an open switch at Waskom this morning. The engineer applied the air brakes and jumped, sustaining a severe sprain of the ankle.

Springfield, O., February 1.—George Wallace, a fireman on the Big Four, while throwing a switch this morning, was run over. His right leg was cut off, and he sustained internal injuries that may prove fatal.

Auburn, Ga., February 1.—The locomotive of a freight train on the Seaboard Air Line jumped the track near here to-day. The engineer and fireman jumped, and the latter was caught between an embankment and a wrecked car and seriously injured.

Pittsburgh, Pa., February 2.—An express train on the Baltimore & Ohio Railroad jumped the track at Woodell this morning, and crashed into a freight train standing on the siding. The engineer and fireman escaped with slight bruises.

Kent, O., February 5.—An Erie engineer was struck by a switch engine in the yards here this morning and his body horribly mutilated. He died instantly.

Roanoke, Va., February 6.—The boiler of a freight locomotive exploded here this evening. The fireman, Dean Henry, was instantly killed, and the engineer so severely injured that he died later from the effects.

Toronto, Can., February 8.—A collision occurred at Agincourt on the Grand Trunk Railway to-day between an express train and a snow-plough that had been sent to relieve it. The engineer and fireman on the express train were both killed.

Toronto, Can., February 8.—A collision occurred between an express train and a local freight near here this evening. Engineer Manning, of the freight, was so badly injured that he died, and his fireman was also seriously injured.

Williamsport, Pa., February 8.—A double-headed train on the Philadelphia & Reading Railroad was wrecked at Allenwood this morning by running into a deep snowbank. Engineer Ehlich was badly scalded.

Arverne, N. Y., February 8.—An express train on the Long Island Railroad ran into a snowbank near here this evening. Engineer Patrick Mahoney and his fireman, David Lavelle, were buried under the engine and crushed to death.

Lindsay, Ont., February 9.—An express train from this point to Toronto ran into a snowbank this morning, and the engineer is missing.

Pittsburgh, Pa., February 9.—William Metzgar, a fireman on the shifter of the New York & Cleveland Gas Coal Company, was killed on the tracks this afternoon. He fell from the locomotive and the cars cut off both legs. He died shortly afterward from the effects of his injuries.

Cincinnati, O., February 9.—The feed pipe on the boiler of a locomotive froze here to-day, and the boiler, exploded. Engineer Frank King and Fireman David Henry were instantly killed.

Dover, Del., February 10.—There was an accident on the Philadelphia, Wilmington & Baltimore Railroad at this point to-day, in which Engineer Benjamin Connor was severely burned about the knees.

Le Roy, N. Y., February 10.—While four Lehigh engines were ramming a snowbank near here to day in order to release a stalled passenger train, the head engine overturned and the engineer, Edward D. Duryea, was caught underneath and instantly killed.

Pittsburgh, Pa., February 10.—Thomas Collins, an engineer on the Baltimore & Ohio Railroad, while trying to get his engine clear of a snow-drift in the Allegheny Mountains to-day had his hands, ears and feet frozen.

Rochester, N. Y., February 11.—William C. Cook, an engineer on the New York Central & Hudson River Railroad, was killed here this morning by striking his head against the woodwork of the bridge over the canal.

Le Roy, N. Y., February 13.—William Benedict, an engineer on the Buffalo, Rochester & Pittsburgh Railroad, fell from his engine here to-day and received such severe cuts about the head that he was rendered unconscious.

Pittsburgh, Pa., February 13.—Two engines on the Castle Shannon Railroad collided near the Monongahela incline this evening. Both engineers and one of the firemen were seriously but not fatally injured.

Rhinecliff, N. Y., February 15.—A freight train on the New York Central & Hudson River Railroad broke in two at this point this morning. When the two parts came together the engine was thrown from the track and into the river, taking the engineer and fireman with it. Engineer Donohue was so badly scalded and injured about the spine that he died from the effects of his injuries. Fireman Reed was also fatally injured.

Pittsburgh, Kan., February 16.—A passenger train on the Atchison, Topeka & Sante Fé Railroad was wrecked just outside of the city limits to-day by being backed into by a coal train. The engineer and fireman were slightly injured.

Guthrie, Ok., February 16.—A collision occurred on the Atchison, Topeka & Santa Fé Railroad between an express train and a stock train near here to-day. The fireman on the freight train had his leg crushed, and both the engineer and the fireman on the passenger train were killed.

Huntington, W. Va., February 18.—A passenger train on

the Norfolk & Western Railroad jumped the track west of here to-day. Engineer Jackson and Fireman Gaze were seriously hurt.

Phillipsburgh, N. J., February 18.—An express train on the Central Railroad of New Jersey ran into an open switch here to-night and was wrecked. The train dashed into a turntable siding on which there were four other engines and a caboose. W. E. Graveling, the fireman on the express, was pinned beneath his engine and badly injured, and two other firemen were badly bruised.

New Albany, Miss., February 19.—Engineer W. H. Milliner was shot and killed on his engine at this point to-day.

Troy, N. Y., February 20.—A collision occurred between an express and a freight train on the Fitchburg Railroad in the yard of this city to-day. The fireman of the express train was bruised.

New Orleans, La., February 20.—A passenger train on the Southern Pacific Railroad was wrecked by running into an open switch at Franklyn to-night. The engine turned over on its side and killed the fireman outright, while the engineer was fatally injured.

Danbury, Conn., February 21.—The boiler of an engine hauling a freight train on the New York & New England Railroad exploded here to-day. The fireman was thrown out of the cab and badly scalded. The engineer escaped unhurt.

Imlay City, Mich., February 22.—A tube in the boiler of a Chicago & Grand Trunk Railway engine collapsed here to-day. The engineer and fireman were slightly scalded.

Portsmouth, N. H., February 23.—A side-rod on an engine hauling a passenger train on the Boston & Maine Railroad broke a few miles from here this afternoon. The fireman, Frank Jones, was struck and seriously injured.

Webster, Mass., February 27.—There was a collision on the Norwich & Worcester Railroad near here this morning. Engineer Arthur Stoddard and Fireman Lewis Williams were slightly injured.

Our report for February, it will be seen, includes 31 accidents, in which 13 engineers and 8 firemen were killed, and 11 engineers and 16 firemen were injured. The causes of the accidents may be classified as follows:

Boiler explosions	3
Breaking in two	1
Broken side-rod	1
Collapsed tube	1
Collisions	7
Derailments	4
Falling from engine	2
Frozen by exposure	1
Misplaced switches	3
Run over	2
Shot	1
Snowbanks	3
Struck by obstruction	1
Unknown	1
Total	31

PERSONALS.

Mr. David Clark, after forty years' service with the Lehigh Valley Railroad Company, has resigned his position and retired from active duties.

Mr. Philip Wallis has been appointed Master Mechanic on the Lehigh Valley Railroad, in the place of Mr. David Clark resigned, and will have charge of the shops at Hazleton and Delano, and the foundry at Weatherby.

Mr. George S. Morison, Civil Engineer, has removed his Chicago office from 184 La Salle Street to Room 1742, Monadnock Block, corner of Jackson and Dearborn streets. His New York office remains at 35 Wall Street, as heretofore.

Mr. F. W. Chaffee has been appointed Master Car-Builder of West Albany Car Shops, of the New York Central & Hudson River Railroad, with headquarters at West Albany, *vice* Mr. L. Packard, deceased.

Mr. F. W. Mahl has been appointed Mechanical Engineer of the Southern Pacific Company, with headquarters at Sacramento, Cal. In addition to such duties as may be assigned to him by the Superintendent of Motive Power and Machinery at Sacramento, he is especially charged with the details appertaining to the establishment and maintenance of common standards for the motive power and rolling stock of the leased, proprietary, and affiliated lines of this Company.

PROCEEDINGS OF SOCIETIES.

The Forthcoming Railway Congress.—The Prince of Wales is stated to have consented to open the International Railway Congress at the Imperial Institute in the first week in July. The British Government has given notice that the foreign delegates to the conference will be received on the part of Great Britain officially, probably at the Foreign Office. The United States has joined the congress, and will send several delegates. The German railways, however, hold aloof.

Civil Engineers' Society of St. Paul.—At the meeting of March 4 Mr. Truesdell read a paper, entitled The First Engineer. Hero, in his opinion, was the man to be honored with this title. Hero was the first to formulate and practically apply, 200 years B.C., the principles of geometry and mechanics. This pioneer instructor in practical science invented land surveying and levelling, and perfected innumerable engines of war and other constructions.

Engineers' Club of St. Louis.—At the meeting of February 20 Mr. J. H. Curtis delivered an address on A System of Water Purification, which he has developed with special reference to the removal of organic matter. He has been experimenting for over two years and has discovered that where sand filters were not submerged, but where the water was allowed to drip upon the sand bed, just as rain falls upon the earth, particles of air followed the drops of water through the sand, making the most complete aeration possible. The author's experiments, however, has only been conducted on a small scale, and he was unable to give any figures as to the actual amount of purification or capacity of filter beds based upon actual service.

The Institution of Junior Engineers.—At the February meeting Mr. A. H. N. Smith, of the Great Northern Railway, read a paper on Locomotive Repairing Work. The author first dealt seriatim with the principal causes rendering repairs to locomotives necessary, the unique character of such work, the various modes of dealing with the different kinds of repairs, and the difficulty of estimating their cost. After a short description of the two classes of locomotive which could best be taken for illustrative purposes—namely, a fast passenger and a heavy suburban engine—it was stated that, excluding accidents, each engine would have run an average of about 75,000 and 55,000 miles respectively before being sent into the shops for repair.

The subject of repairs could well be considered under four divisions. (1) boiler, (2) frames, wheels, etc., (3) motion, (4) general work. The work usually required on the boiler consisted of patching of fire-box in various ways, putting in new tube-plates, tubes, and stays, and repairing of damage caused in the smoke-box chiefly by heated ashes. The life of a boiler (which depended very much on the nature of the material used in its construction and on the quality of the water with which it was fed) might be taken as 15 years if of steel, and 20 years if of iron. The proper adjustment of the lifts in the various clack-boxes was insisted on, such having an important effect upon the steaming of the boiler.

Repairs to cylinders were next considered, including patching of cracks. The use of asbestos for making joints was deprecated, as that material was found to corrode the cast iron; the mode of repairing such damage by brass patching was described. The facing up of the ports was then illustrated.

The manner of testing the frames for squareness, of repairing fractured horn-blocks, of fitting axle-boxes and marking them off for boring out received attention. The wearing of tires was then investigated, and interesting methods of discovering flaws in axles were enumerated. The letting together of brass motion bushes, the fitting and lapping of quadrant dies and links, the renewal of motion-pins, repairing of reversing-gear, the wear of piston cotters and eccentric liners were each fully treated upon, and the paper concluded with a description of the two processes of setting slide-valves—by the lead and travel—and practical observations on the fitting of regulator valves, the even distribution of the engine's weight on the springs, and repairs to the automatic brake-gear.

Engineers' Club of Philadelphia.—At the meeting of March 2 Mr. C. H. Ott described an ingenious solution of a problem in hydrostatics that had been brought to his attention at the town of Anniston, in Alabama. A well 80 ft. deep had been used as the source of water supply for the

town, but as the town grew this supply became inadequate, and a new well was started about 40 ft. east of the old one. A shaft was driven to a depth of 120 ft., where a flow of water was obtained. In order to provide storage for water, and to connect the new shaft with the old pumping-well, a timbered drift was run directly beneath and about 40 ft. below it. The water supply not yet being deemed sufficient, an 8-in. well, cased with pipe, was bored in the new shaft to a depth of 230 ft. below the pump-house floor, and a great flow of water was struck. The drill, in passing through the disintegrated limestone, bored a much larger hole than 8 in. in diameter, so that large quantities of water passed up outside of the casing. When the depth of 230 ft. was reached, the latter quantity was so great that the water-level in the new shaft could not be lowered and maintained with the apparatus at hand to more than about 20 ft. below the pump-house floor. An 8-in. hole was then drilled from the bottom of the pumping-well to the drift below. It was still found impossible with all of the pumps and jet apparatus available to lower the water-level in the pumping-well to more than about 25 ft. below the pump-house floor, thus furnishing an ample water supply.

Some months after these arrangements had been finished a failure occurred in the pump-cylinder under 50 ft. of water, and with no apparatus available to lower the water in the well sufficiently to make the necessary repairs. After several expedients had been tried, the following contrivance was devised:

A balloon-shaped bag in dimensions about 3 ft. in diameter and 6 ft. long was made of six plies of bed-ticking, roughly quilted into squares. The bag was soaked in linseed-oil and a quantity of rye flour inserted and well shaken around. An inch pipe terminating in a sleeve was inserted in the mouth of the bag, which was then securely wired around the pipe. Sewn to the bottom of the bag was a stout ring, and to this was wired a half pig of iron by a ring bolt inserted into its end. The bag was then wrapped tightly with twine into a cylindrical shape, and was lowered into the drill-hole in the pumping-well by means of sections of pipe until the weight struck bottom; by estimation one half of the bag entering the drift below, the remainder being in the drill-hole. The inch pipe was then attached to the service main, through a stop-cock and a pressure-gauge attached thereto, and the bag was slowly distended until a pressure of 50 lbs. per square inch was reached and maintained. The upper part of the bag swelled out and accommodated itself to the irregularities of the drill-hole, the lower part of the bag swelled out into a bulb shape, the whole resembling an inverted champagne bottle cork. The drainage pump and steam jet were then set to work and speedily emptied the pumping-well, the bag being held in shape during the lowering of the water by an interior water pressure of about 10 lbs. per square inch in excess of the exterior water pressure. The repairs to the pump having been readily made, the water was exhausted from the bag and the apparatus withdrawn.

NAVAL AND MARINE NOTES.

Washington Coal.—It is reported that recent tests of Washington coal go to show that there is an unlimited source of good steam coal in the Puget Sound country.

Device for Stopping Shot Holes.—A device for stopping up shot holes in war vessels, invented by a marine engineer named Douglas, and accepted by the British Government, has been tested by the United States cruiser *Chicago*. It resembles a parachute with a rubber cover supported by steel ribs. It is pushed through the hole made by the shot, when it expands and clings close to the outside of the vessel, preventing an inrush of water.

The Blake Pump has been adopted by the Newport News Ship Building and Dry Dock Company for the United States gunboats Nos. 7, 8 and 9, the contract having been awarded to the George F. Blake Manufacturing Company, 95–97 Liberty Street, New York. The contract includes Blake's special design of vertical duplex boiler feed pumps, fire pumps, and bilge pumps, also an outfit of pumps for the distillers and evaporators.

Additions to the Navy.—Three new vessels will shortly be placed in commission—the armored cruiser *Maine*; the double-turret monitor *Amphitrite*, now ready for service at Norfolk; and the third, the cruiser *Boston*, which has been lying idle at the Mare Island Navy Yard for months waiting a complement of men. Following close upon these ships will be the battle-ships *Indiana* and *Massachusetts*, and the monitor *Terror* at New York. The latter will be ready for service in April, and the battle-ships in the early summer.

Carrying Capacity of a Torpedo.—An experiment was recently made at Willett's Point to test the ability of the Sims-Edison torpedo to bear the weight of a man. A chair was lashed to the top, and the man stationed thereon took a ride at the rate of about 18 miles an hour, having the torpedo under perfect control at all times, the electric current being supplied from the shore.

The "Northland."—This vessel, which is an exact duplicate of the *Northwest*, was launched from the yards of the Globe Iron Works, at Cleveland, early in January. The two boats are the only ones on the great lakes ever built exclusively for the passenger trade. The electric plant includes a powerful electric search-light of 100,000 candle-power. She will carry 442 cabin and 211 steerage passengers, and a crew of 150 men. The *Northland* will run with her sister ship, the *Northwest*, between Buffalo, Cleveland, Mackinaw and Duluth. She cost about $750,000.

Test of an 18-in. Carnegie Armor Plate.—A nickel steel Harveyized armor plate was tested at Indian Head on March 11. Two shots were from a distance of 290 ft. from the plate. The first was a Carpenter projectile with a powder charge of 295 lbs. This penetrated about 4 in. and was broken to pieces, but did not crack the plate. A second projectile of the same kind was then fired with a charge of 395 lbs. of powder. It struck the plate about 2 ft. to the right of the first one, and penetrated 7 in., its base being again broken to pieces. A long, vertical crack was made, extending from the top to the bottom of the plate, but, unlike former tests, there was no longitudinal crack. The test was considered very satisfactory.

The British Admiralty and Dynamite Guns.—The New York *Sun* is authority for the statement that "a special committee has been sitting at the Admiralty, on and off, for months past, considering the question of pneumatic guns. Reports were received a few weeks ago from the United States which appear to have suddenly overcome the conservative reluctance to this new-fangled American thing, and orders have been issued for carrying out a series of experiments in Milford Haven. Absolute secrecy is observed on the subject at the Admiralty. Rumor has it that a gun has been brought from America for trial, and that a certain syndicate stands to win an enormous stake in the event of its proving successful. But another and equally credible report says that a pneumatic gun of British invention has been made at the Government torpedo works at Woolwich, where every foreman and mechanic is sworn to secrecy."

Telephoning to and from a Light-ship.—Professor Lucien J. Blake, of the Chair of Physics and Electrical Engineering at Kansas State University, at Lawrence, has recently been experimenting at Sandy Hook, with a view of establishing communication by wire between the land and a light-ship anchored several miles out in the ocean. The difficulty is that the ship riding at anchor is continually changing its position, and breaks any wire or cable that is fastened to it. Professor Blake conceived the idea—and has carried it out successfully in practice—of attaching to the anchor another chain leading toward the shore for a sufficient distance, so that neither the end of chain nor the water will be disturbed by the tossing of the ship, and there make his connection with the shore cable. This system was completed recently, and the first telephone message that ever passed between a ship anchored out at sea and the land was transmitted from Scotland Light-ship to Sandy Hook.

Dry-Dock at Port Royal.—This dock, which is nearly completed, is the largest in the country, and is capable of accommodating the great battle-ships now building. No other dock is large enough to hold them. Its length is 627 ft., with a maximum breadth of 76 ft. and minimum breadth of 44 ft., and is the first of the three large docks now building to be finished. The dock building at New York is practically of the same dimensions as that at Port Royal. A third dock, which is to be the greatest in the country, is now rapidly progressing toward completion at Puget Sound, and, when finished, will be the finest in the world. This dock is intended to be used in docking the battle-ships and large cruisers stationed on the Pacific Coast, where there are no facilities now adequate for the purpose.

Land has been purchased at Algiers, opposite New Orleans, for the site of a fourth great dock, and an appropriation of $250,000 has been asked by the Secretary of the Navy to begin the work, which will cost $1,250,000 when completed.

These docks will be ample, it is believed, to meet all requirements of the naval service for many years. The completion of the dock at New York will give that yard two first-class docks. There are now two at Norfolk, and the new ones at Port Royal and Algiers will make four in the South. The dock at Puget Sound and the two docks at Mare Island will be sufficient, it is said, for the Pacific station.—*New York Sun.*

Largest Tow Barge in the World.—Eastern capitalists, it is said, are to build at Chicago the largest tow barge in the world, the measurements of which will be: Keel, 352 ft. and 365 ft. over all; beam, 44 ft.; and depth of hold, 26 ft. On the present draft of 14½ ft. of water in the locks at Sault Ste. Marie the new boat will carry 4,500 tons. On the 18 ft. of water, when the 20-ft. channel between the great lakes shall have been completed, it will carry easily 6,000 tons. The vessel will have no spars at all for use of canvas, and will be towed exclusively. It will be of the best steel construction throughout. Ship-building in all branches promises to have an unprecedented boom at Chicago this spring. Contracts for two steamers nearly 400 ft. in length, and for two steel schooners with keels of more than 300 ft., have recently been made, and the capacity of boats under construction on the Calumet at the present time is about 24,000 tons. "The remarkable increase in the size of lake vessels this winter has been viewed," says a local paper, "with undisguised alarm by the owners of boats which have formerly done the bulk of lake carrying. They have viewed with considerable misgivings the coming of steamers and schooners which could take on board 6,000 tons in a single cargo with no corresponding increase in cost of operation. On what the outcome of this struggle between the old and new will be no two marine men can agree. It is evident, however, from the contracts which one ship-building company has taken, and the work of the other ship-yards around the lakes, that the coming lake carriers will be of the 6,000-ton class, and the owners of boats built before the 20-ft. channel became a part of the policy of the general government must adjust their interests to meet the competition of the larger craft."

Test of 15-in. Armor Plate.—A test of thick Harveyized armor took place at the Bethlehem Iron Company's proving ground recently, in the presence of Captain Sampson and the Armor Board. The plate was curved, 15 in. thick, 15 ft. 9.5 in. long, and 6 ft. 9.5 in. wide. It weighed 29 tons, and was held up to a backing of 36 in. of oak, by twenty-two 3.2-in. bolts. It represented the group composed of the 13-in. gun turrets of the *Indiana* and *Massachusetts*, composed of 24 plates, weighing in the aggregate 716 tons, the largest group of armor tested under the contract.

As the plate, which was comparatively narrow, was to be tested with the 10-in. gun, some anxiety had been expressed as to its liability to crack across, a method of failure which seems to be peculiar to thick and narrow Harveyized plates. This fear proved groundless.

The first impact was delivered upon the middle line, 18 in. to the left of the normal point, about the centre of the plate, with a velocity of 1,539 foot-seconds, the charge being 167 lbs. of brown powder. The 500-lb. shell penetrated about 5 in., its head welding fast and the remainder breaking up, the largest fragment, weighing about 50 lbs., rebounding 40 ft.

No cracks whatever appeared, nor were any of several chill cracks in the surface extended or deepened. The flaking was slight and the bolts and backing intact. The second shot, also a 500-pdr., struck the middle line of the plate, 36 in. to the right of the first, the velocity being 1,940 foot-seconds and the charge 241 lbs. It penetrated about 7 in., the head welding and the body and base breaking up. There was a trifle more flaking, but plate, bolts, and backing were, in all respects, sound and intact.

The New Torpedo-boats.—Proposals were opened at the Navy Department on February 19 for the construction, exclusive of armament and torpedoes, of three metallic twin-screw sea-going torpedo-boats of about 138 tons displacement with a speed of 24½ knots, maintained for at least two consecutive hours.

Proposals of two classes were permitted, one adhering strictly to the plans and specifications prepared by the Navy, and the other upon designs of the bidders fulfilling the conditions of speed and economy prescribed by the Department. The proposals will all be referred to a Board of Bureau Officers, including Chief Constructor Hichborn, Engineer-in-Chief Melville, and Judge Advocate-General Lemly, who will report to Secretary Herbert on the plans; and it is not expected that the contracts will be awarded for at least a month. The bids for the new torpedo-boats were:

Bath Iron Works, Bath, Me.—Department plan, all three boats, $142,000 each. Total, $426,000.

John H. Dialogue & Son, Camden, N. J.—Department plan: One boat, $136,000; two boats, $137,000 each; three boats, $135,000. Total, $408,000.

Columbian Iron Works, Baltimore.—Modified plan: One boat, $107,000; two boats, $103,000 each; three boats, $97,500 each. Total, $292,500.

Hugh Ramsay, Perth Amboy, N. J.—Five proposals. Modified plan, all three, $438,000. Another modified plan, all three, $378,000. Department plan, all three, $378,000. Department plan, all three, $347,700. Modified plan, all three, $347,000.

Union Iron Works, San Francisco—Department plan: One boat, $135,000; two boats, $129,000 each; three boats, $120,000 each. Total, $360,000. Modified plan: One boat, $125,000; two boats, $120,000 each; three boats, $116,000 each. Total, $348,000. Modified plan—Larger boat, 240 tons displacement and 28 knots speed, one boat, $243,000.

Fulton Engineering and Ship-building Works, San Francisco—Department plan: One boat, $148,000; two boats, $145,000 each.

Iowa Iron Works, Dubuque, Ia.—Department plan, all three, $137,000 each. Total, $411,000.

Herreshoff Manufacturing Company, Bristol, R. I.—Modified plan, three steel of 138 tons, for $113,350 each. Total, $341,550. Modified plan, three bronze hull, aluminum top, boats, for $138,000 each. Total, $414,000. Modified plan: One steel boat, $113,815; two composite boats, $138,000 each. Total all three, $389,815. Modified plan, one composite boat, $138,000; two steel boats, $113,850. Total, $365,700.

COMPULSORY ARBITRATION.

A BILL has been passed by the House of Representatives at Washington, "to establish a system of arbitration between carriers employed in inter-State commerce and their employés."

It provides that when a dispute occurs between "carriers" and their employés, that the Chairman of the Inter-State Commerce Commission and the Commissioner of Labor "shall, upon the request of either party to the controversy, with all practicable expedition put themselves in communication with the parties to such controversy, and shall use their best efforts, by mediation and conciliation, to amicably settle the same." If such efforts are unsuccessful, the bill provides for the appointment of arbitrators and the submission of the questions in dispute and the decision of the same. The bill provides further:

"That the respective parties to the award will each faithfully execute the same, and that the same may be specifically enforced in equity so far as the powers of a court of equity permit; except *that no employee shall be punished for his failure to comply with the award as for contempt of court.**

"That employés dissatisfied with the award shall not, by reason of such dissatisfaction, quit the service of the employers before the expiration of three months from and after the making of such award, nor without giving 30 days' notice in writing of their intention so to quit. Nor shall the employer dissatisfied with such award dismiss any employé or employés, on account of such dissatisfaction, before the expiration of three months from and after the making of such award, nor without giving 30 days' notice in writing of his intention so to discharge."

During the pendency of arbitration employers are prohibited "from discharging the employés, parties thereto, except for inefficiency, violation of law, or neglect of duty, nor for the organization representing such employés to order, nor the employés to unite in, aid, or abet strikes or boycotts against such employer. . . . Any violation of this section shall subject the offending party to liability for damages, which may be recovered in an action upon the case brought by any person, persons, or corporation who shall have received or incurred any loss or damage by reason of such unlawful act."

It is provided further, "that in the articles of incorporation and in the constitution, rules, and by-laws that a member shall cease to be such by participating in, or by instigating, force, or violence against persons or property during strikes, lock-outs, or boycotts, or by seeking to prevent others from working through violence, threats, or intimidation."

Section 6 provides that any violation thereof "shall subject the offending party to liability for damages." It is not made plain, though, how such damages could be collected from a labor union if it had no property, or from its members if they

* The italics are ours.—EDITOR.

had none. Members under this act cannot be punished for contempt of court, and the only penalty which apparently can be enforced, is that if he is guilty of instigating force or violence against persons or property during strikes, etc., or shall prevent others from working through violence, threats, or intimidation, "he shall cease to be a member" of his incorporated union. This is very mild punishment.

Another important provision is that incorporated unions "may appear by designated representatives before the board created by this act." The right of a union of appearing, or being represented by deputy, is one which has long been a subject of dispute between the employés and employers. It is a just claim, and is recognized in the act before us.

But what shall be said of a law which provides penalties which can be enforced against one party and not against the other? Before the unions should be authorized to appeal to such a board, they ought to give some adequate security to fulfil the provisions of the act, or pay the penalties imposed.

Compulsory arbitration would be tyranny, and would be sure to arouse a storm of indignation if it were enforced.

Manufactures.

THE "INTERNATIONAL" INJECTOR.

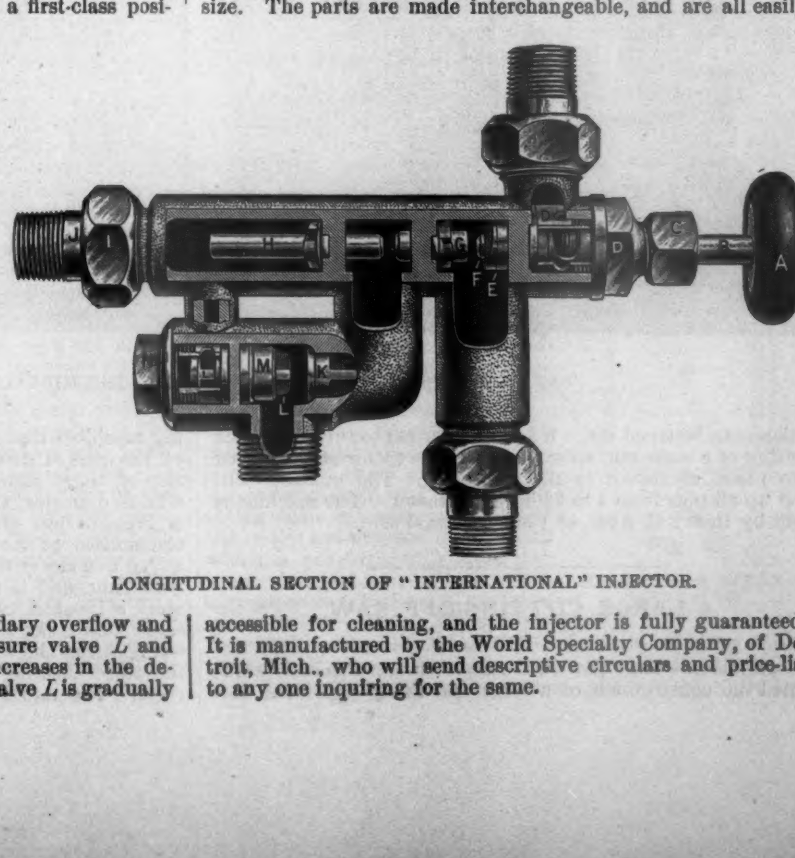
We illustrate herewith a new injector for which the makers claim remarkable and wonderful results. During the past few years a great number of automatic injectors have been put on the market, but in the main features and methods of operation they have in great measure copied one another, and none of them have been able to produce better results than others which have gone before. Up to the present time automatic injectors have been limited in their range, as it has always been found impossible to retain the automatic qualities and at the same time handle a hot water supply, or give the injector a greater range than 120 to 130 lbs. between highest and lowest steam pressures. The positive injector reached its limit 15 years ago; and while it has secured better results on hot water than the automatic injectors, yet a first-class positive injector is high priced, and requires considerable attention from the operator.

The "International" injector is a new departure, being based on new principles, by virtue of which it combines all the good features of both automatic and positive injectors of the past, and surpasses both in working qualities. The principal new feature in the "International" is the fact that the current of water to the boiler is established against atmospheric pressure instead of against direct boiler pressure, as heretofore. This is accomplished by the combination of an overflow valve, *K* (fig. 2), and pressure valve, *L*. When the injector starts, the steam passing through the steam jet *F* and suction jet *G* passes down through the overflow chamber, forcing valves *K* and *L* away from their seats, and opening the passageway through the overflow for the escape of steam, which by its pressure against the valve *H* holds both valves away from their seats. A vacuum being created between the jets *F* and *G*, the water is lifted, and passing through the suction jet *G* and combining and delivery jet *H* on its way to the boiler, passes down through the secondary overflow and out through the passageways between pressure valve *L* and pressure valve collar *M*. As the pressure increases in the delivery chamber around the delivery jet *H*, valve *L* is gradually forced to its seat against the collar *M*, but does not finally close until the current to the boiler is firmly established.

THE "INTERNATIONAL" INJECTOR.

The valve *K*, in the mean time, is closed by the vacuum in the overflow chamber. By a new construction of the parts in the steam chamber, the same valve handle *A* opens the valve admitting steam to the injector, and at the same time regulates the amount of water supply; therefore no valve is required in the suction pipe, nor is one necessary in the steam pipe except as a convenience should it be desired to remove the injector at any time while carrying steam on the boiler.

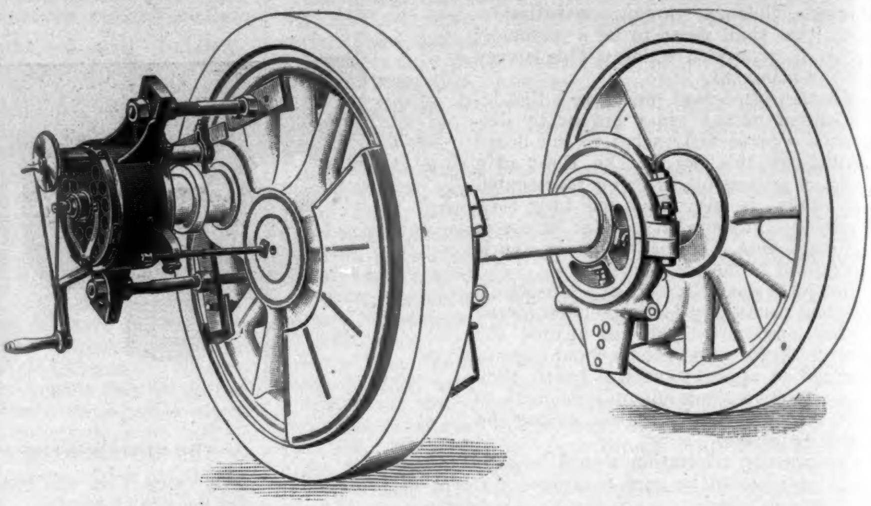
Another new feature is the fact that the combination and delivery jet *H* has no spill holes, and will therefore outwear three of any other make. The makers claim for this injector that it will start at 13 to 15 lbs. steam pressure and work from that point up to 250 lbs. steam pressure, giving it a range of 235 lbs., which is 100 lbs. greater than any other automatic injector. It is automatic and restarting at any and all pressures. It lifts the water vertically 20 to 22 ft., and handles a hot-water supply of 135° at 65 to 80 lbs. of steam, 125° at 125 lbs. of steam. By delivering the minimum capacity it will put water into the boiler at 200° at 80 lbs. of steam, and at 260° at 150 to 200 lbs. of steam, the water being taken from a 4-ft. lift at 74°. One of the most remarkable features about this injector is its grading capacity. The best injectors heretofore manufactured have a grading capacity of only about 40 to 50 per cent., while the minimum capacity of the "International" is 66⅔ per cent. less than the maximum capacity of the same size. The parts are made interchangeable, and are all easily accessible for cleaning, and the injector is fully guaranteed. It is manufactured by the World Specialty Company, of Detroit, Mich., who will send descriptive circulars and price-list to any one inquiring for the same.



LONGITUDINAL SECTION OF "INTERNATIONAL" INJECTOR.

PORTABLE CRANK-PIN TURNING MACHINE.

THIS machine is of a very simple design, and works most effectively. It is so constructed that it will turn either long or short pins that are collarless or have a collar, and that, too, without the use of any offset tools. In order that the work may be perfectly true, the machine may be lined either with the face of the hub or with the bore of the wheel, and it will therefore run true with the original pin. For turning the outer end of pins the tool is held close to the main body of the machine, but for pins with two bearings an extension bar is used for reaching the inner one. A large shell is used to hold the working portions of the tool, and is clamped solidly to the wheel by the two large lugs shown in the engraving. There are also two smaller lugs that carry set screws which act as feet for it to stand upon and serve to true it into accurate alignment. At the centre of the shell there is a large set screw that enters the drilled centre of the pin and serves to secure the central adjustment.

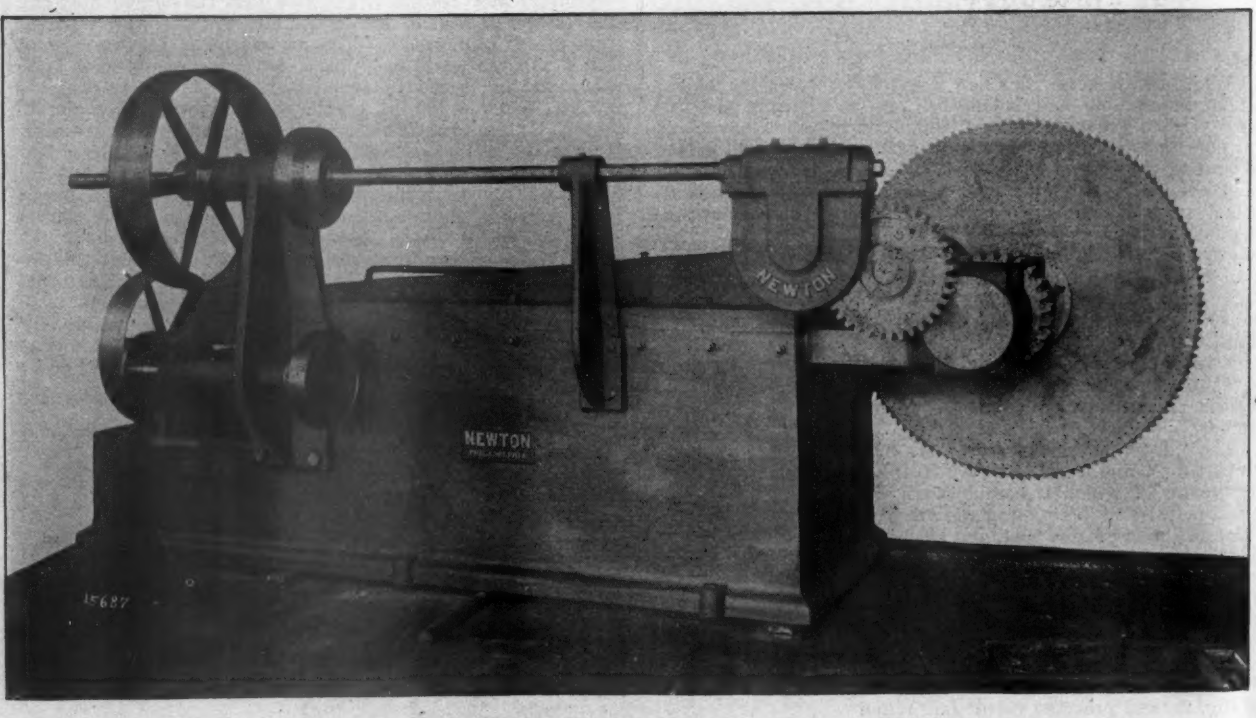


PORTABLE CRANK-PIN TURNING MACHINE.

Inside the shell there is a second shell that revolves, carrying a tool-post with it, this tool-post being fed out and in by a screw operated either by hand or the small belt shown. With this device, not only the bearing, but the faces of the collars, can be trued up. When it is desired to turn the inside bearing of a main pin, an extension to the tool-post is screwed into place, as shown in the engraving. The machine will true up all pins from 4 to 7¼ in. in diameter. The machine is built by Henry C. Ayer, of Philadelphia, Pa.

A LARGE CUTTING-OFF SAW.

THE Midvale Steel Works, at Nicetown, have recently completed the construction of a large and finely appointed machine shop, to be used in connection with the heavy gun and other work that they are doing for the Government and the builders of large vessels. The new shop is equipped with electric travelling cranes of the Shaw design that span the whole floor, and are available for placing work in any of the tools. These tools consist of heavy gun lathes and planers, and among others the heavy cold saw made by the Newton Machine Works of Philadelphia, an engraving of which is given herewith. This machine is one of the largest cold sawing machines that has been built, and is intended for cutting off the ends of steel ingots that are to be used in the construction of heavy ordnance. The saw that is shown in place is 6 ft. in diameter, and is driven by the system of gearing that is brought out quite clearly in the engraving. Power is transmitted to the main pulley shown at the left, which is keyed to a sleeve through which the shaft carrying the worm gear runs, and is revolved by a feather in the sleeve. The work is blocked solidly, and the saw fed through it by a feed screw that is not seen in the engraving. As the head travels out it carries the worm with it, and the whole is supported by the ample bearing surfaces provided by the tail of the carriage. The rate of feed can be varied according to the size

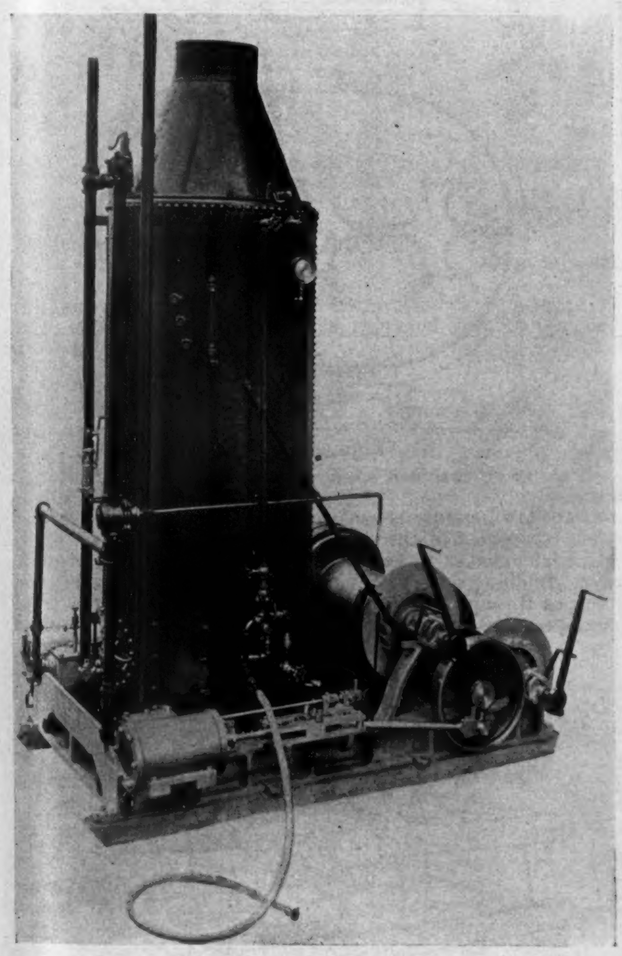


SAW FOR CUTTING OFF STEEL INGOTS AT THE MIDVALE STEEL WORKS.

of the piece to be severed, and the power of the machine is such that it will cut through an ingot measuring 20 in. × 20 in. in two hours.

MUNDY'S HOISTING ENGINE.

The hoisting engine and boiler, of which we give an illustration, is one that is made by Mr. J. S. Mundy, of Newark, N. J. While the whole machine is very compact and easily moved, the designer has apparently found that he had ample space within which to work, and has succeeded in so working out his details that all of the parts are readily accessible. The great difficulty that is experienced with many engines of this class is that the designer has utterly lost sight of the fact that machinery will not run forever without repairs, and the result is that no provision is made for rendering them easy. Everything about the engine itself is as easily inspected as though it was alone in the centre of a 10-acre lot. The steam chest, which is almost necessarily between the cylinder and the boiler, and which is usually crowded so close to the latter



MUNDY'S HOISTING ENGINE FOR RAILROAD WORK.

that the setting of the valve must be done with the aid of some wild guessing, is in this case flat, with the cover on top, and has the valve riding on a horizontal seat. The inspection and repairing is therefore easily and quickly done, without involving any contortions on the part of the repairer. The piston is packed by rings sprung into grooves in a solid head, and is turned a trifle larger than the bore of the cylinder. It is also thinner on the side where the split is made than on the opposite, the claim being that, in this way the outward pressure of the spring is made more even. Cast iron is used both for the cross-head and guides, and gives most excellent results The guides are of the four-bar locomotive type. Great care has also been taken in the counterbalancing of the cranks to produce even running. The hoisting drum is driven by a friction clutch composed of a cast-iron female and wooden male parts, bevelled to an angle of about 45°. The wood wears on the end of the grain and is very long lived.

The arrangement of the operating handles is clearly shown in the engraving, the whole being bunched together so as to be within easy reach of the driver. On one end of one of the spool-shafts, not shown in our engraving, it is customary to put a winch spool, for hauling in on any line that may be desired. Great care has been taken in the designing of the outlines of these spools, so that the ropes will deliver freely. Repeated trials at last evolved a form of spool that will do it, and this form is invariably used. Great care is taken in the workmanship and fitting, so that the inevitable day of repairing shall be postponed as long as possible.

Recent Patents.

WATER-TUBE BOILER.

Mr. John Vanes, of Brazil, Ind., has patented the water-tube boiler shown by fig. 1. It consists, as will be seen, of inner and outer cylindrical shells, *A* and *F*, with an internal fire-box, *G'*. Over this fire-box is a water and steam chamber, *J'*, and at the opposite end another water chamber, *J''*, is formed by the inner and outer shells and the tube-sheet *E*. As will be seen, both the tube-sheets *E* and *D* and the tubes *J* are inclined. There is a smoke and combustion chamber above

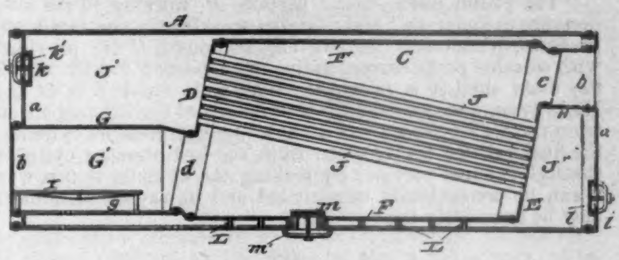


Fig. 1.

VANE'S WATER-TUBE BOILER.

and below the tubes, the passage *b'* leading to the chimney. Manholes *k* and *l* give access to the chambers *J'* and *J''*, from which the tubes may be cleaned or caulked or removed. The patent is dated October 16, 1894, and is numbered 527,631.

STEAM SEPARATOR.

No. 531,638, January 1, 1895. This invention is illustrated by fig. 2, which represents a section of the apparatus. Steam is admitted to it by the passage *b*. It then strikes the inclined plates *e e* and is deflected downward through the narrow passages *l l* around the pipe *g* into the chamber *k*. It then rises through the pipe *g* and passes through the passage *c* to its destination. It is claimed that the effect of the downward current is to deposit the watery particles contained in the steam in the chamber *k*, from which the water which is collected therein can be drained by a discharge pipe, *m*. John McCaffrey, of Pittsburgh, Pa., is the patentee.

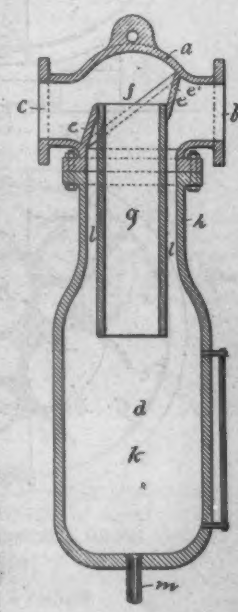


Fig. 2.

McCAFFREY'S STEAM SEPARATOR.

CYLINDER FOR ENGINES, MOTORS OR COMPRESSORS.

No. 533,240, January 29, 1895. Fig. 3 shows the form and arrangement of cylinder which Mr. Conrad Sonderman, of Landsberg, Germany, has patented. He describes his invention as follows:

"*A* represents the main shell or casing, the central portion of which is accurately bored and forms the low-pressure cylinder. In each end of the shell or casing *A* is placed one of the end sections *B C*, each of which is provided with a central bored chamber forming one of the high-pressure cylinders. I prefer to form the end sections *B* and *C* as shown with air spaces *H* between their inner and outer walls, the said air spaces acting to prevent to a certain extent the loss of heat from the high-pressure cylinders by radiation.

The end sections B C extend within the main shell or casing A to the bored portion which forms the low-pressure cylinder, and said end sections are secured to the main shell by bolts or screws or in any other desired manner.

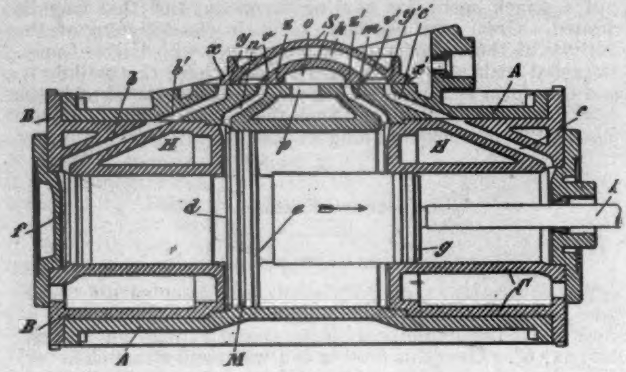
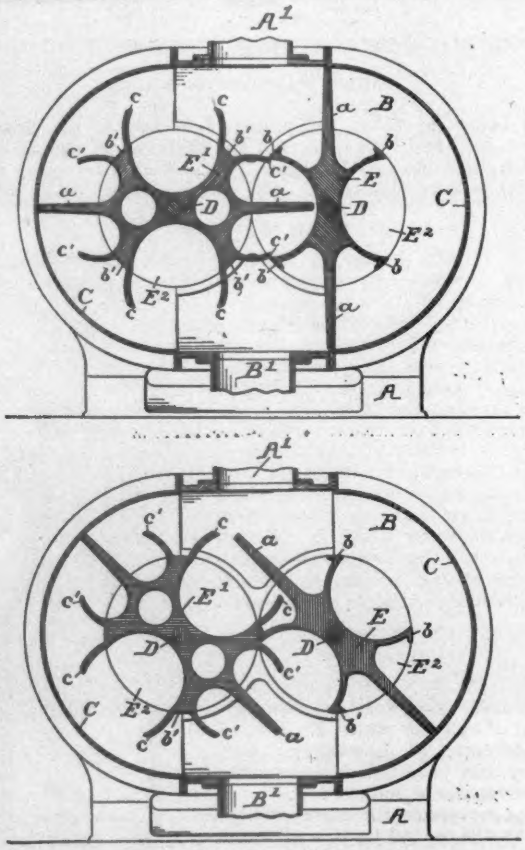


Fig. 3.

SONDERMAN'S COMPOUND ENGINE CYLINDER.

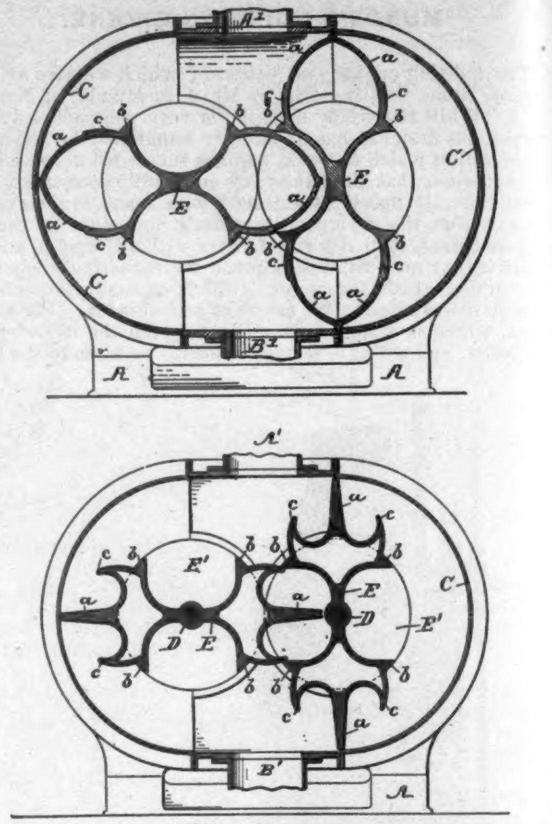
"The piston has a central portion, M, working in the low-pressure cylinder and end portions working in the two high-pressure cylinders. The two end sections B C are provided with suitable ports corresponding with ports b' c' with which the main shell A is provided. The slide valve S is of the Hicks type, and provides for the passage of the exhaust steam from the high-pressure cylinders to the low-pressure cylinder, the final exhaust taking place from the low-pressure cylinder through exhaust port p. By making the cylinder in this way it can be conveniently constructed and its several chambers may be accurately bored.



Figs. 4 and 5.

GREEN'S ROTARY BLOWERS.

"The cycle of movements in the working engine is as follows: In the position shown by the drawing the piston has completed its return stroke, and is now required to move in the direction indicated by the arrow. By the linear motion of the slide S the edge x opens the port b b' to live steam, and at the same time the edge y' opens the port c c' and allows the exhaust steam from the front high-pressure part of the cylinder to pass the edge v and through the ports c c' h n to the surface d of the piston in the low-pressure part of the cylinder. By the combined forces of the steam the piston and piston-rod k are moved forward, the live steam acting on the surface f



Figs. 6 and 7.

GREEN'S ROTARY BLOWERS.

and the low-pressure steam upon the surface d. At the same time the edge z' of the slide valve opens the port m to allow the final exhaust to leave the low-pressure part of the cylinder. In doing so it passes under the shell o of the valve and escapes through the outlet p. The exhaust from the front high-pressure part is prevented from passing from the passages

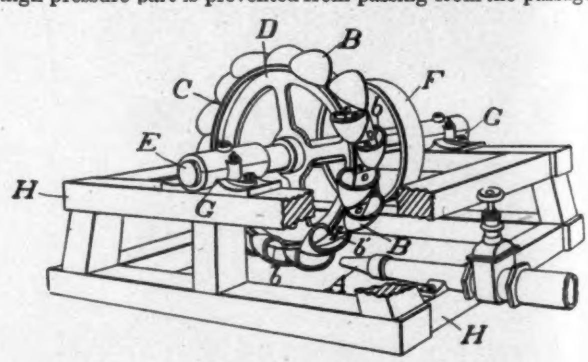


Fig. 8.

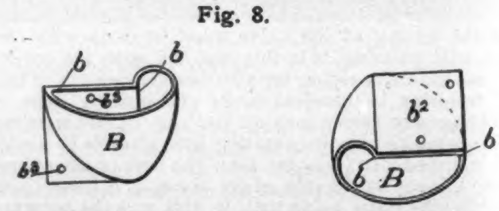


Fig. 9. Fig. 10.

TUTHILL'S ROTARY HYDRAULIC MOTOR.

c c' to the passage m by the edge v' of the slide valve. When the piston has completed its stroke the slide valve has advanced and opened the ports c c' by the edge x', having passed the port c' so that the live steam may pass in, and the passage m is opened between the edges y and v' to exhaust the steam

from the back high-pressure part, while the edge z permits the escape of the exhaust steam from the low-pressure part through the passages n and m. This construction of cylinder may be adapted with advantage to locomotives and traction engines.

"With gas and petroleum motors the low-pressure part is used as a pump and the two high-pressure parts to develop the power, the spaces H in the shells of the high-pressure parts B and C being connected with a water supply for cooling purposes. If it be desired to use the construction in an air or gas compressor, the air or gas is drawn in through the passage p and brought alternately through the front and back high-pressure ports."

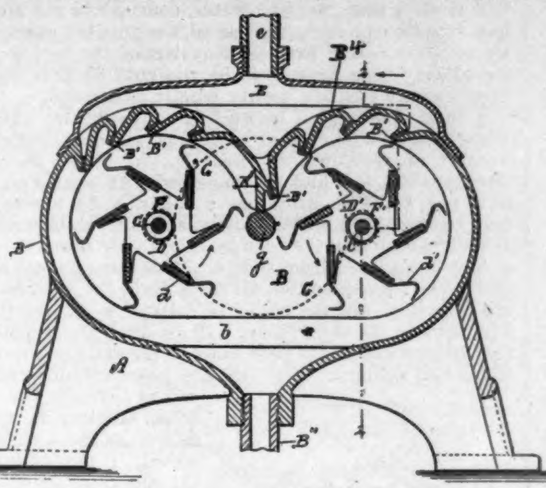


Fig. 11.

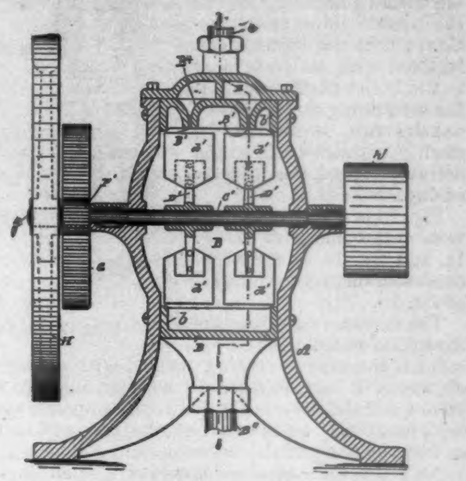


Fig. 12.

ROGERS' ROTARY WATER MOTOR.

ROTARY BLOWERS.

Nos. 533,291, 533,292 and 533,293, January 29, 1895. In these patents Mr. Thomas W. Green, of Philadelphia, has described some very ingenious forms of rotary blowers, the construction of which will be sufficiently apparent from the engravings (figs. 4, 5, 6 and 7) without other description. The improvement consists in the form and construction of the "revolvers," which engage with each other in pairs.

ROTARY HYDRAULIC MOTOR.

No. 534,772, February 26, 1895. Of this invention the patentee, Mr. Stephen J. Tuthill, of Ashland, Ore., says:

"Its object is the thorough transfer of working force from a jet of water moving with high velocity to a water-wheel of this description through the agency of buckets of original design.

"It consists particularly in the individual shape of the buckets, which, each by its single flat side, is bolted upon the face of a wheel set vertically, in such manner as to be firm in place and to present to the jet a bucket mouth, the edges of which may be thinned and rounded, extending quite across and alternately over and below the opposite edges of the wheel face, thus preserving a wide opening through which the water, having given up its energy as the buckets leave it, may drop into the sluice beneath the motor. Such buckets are readily removed and replaced, and their size and that of the wheel and connections depends upon the pressure of fluid at hand."

Fig. 8 is a perspective view of the motor, and figs 9 and 10 separate views of one of the buckets. A is the nozzle terminating the service pipe by which the jet is directed upon the buckets B. The easy curving walls and bottoms of the buckets turn the stream gradually from its first course during such a period of its flow through them as will cause the resultant of the pressure due to the momentum of the water to be exerted in the central vertical plane of the wheel and face, in this way avoiding injurious lateral vibrations.

ROTARY WATER MOTOR.

No. 534,916, February 26, 1895. Columbus K. Rogers, Salem, Mass., inventor. Figs. 11 and 12 are respectively longitudinal and transverse sections of this motor, which consists of two pairs of motor wheels D and D' having curved blades d d' of the form shown. These wheels are mounted on shafts C and C', on which pinions F F' (shown by dotted circles in fig. 11) are secured. These pinions gear into a spur gear, G, attached to the motor shaft g, which is also provided with a fly-wheel, H, and band pulley h.

Above the wheel chamber B is located the pressure chamber E, which is separated from the wheel chamber by a partition, B^4, which is of the form of two arcs of a circle arranged side by side upon a common base, which shape causes the partition to closely conform to the shape of the motor wheels. The partition B^4 is provided with two series of ejector nipples that project downward at a tangent to the two wheels, the nipples of both series being inclined in the same direction so that the wheels will be rotated in the same direction. From the centre of the partition B^4 depends a division wall, B^5, that extends down to the motor shaft g and separates one motor wheel from the other and prevents any back pressure on the blades of the wheels, and also prevents any water ejected against one of the motor wheels striking the other. The chamber E is connected by means of a pipe, e, to any suitable source of water pressure.

The water from the pressure chamber E is forced through a series of ejectors B' B' against the fans or wings d d' of the wheels D D', thus causing the latter and their shafts to be set in a rotary motion.

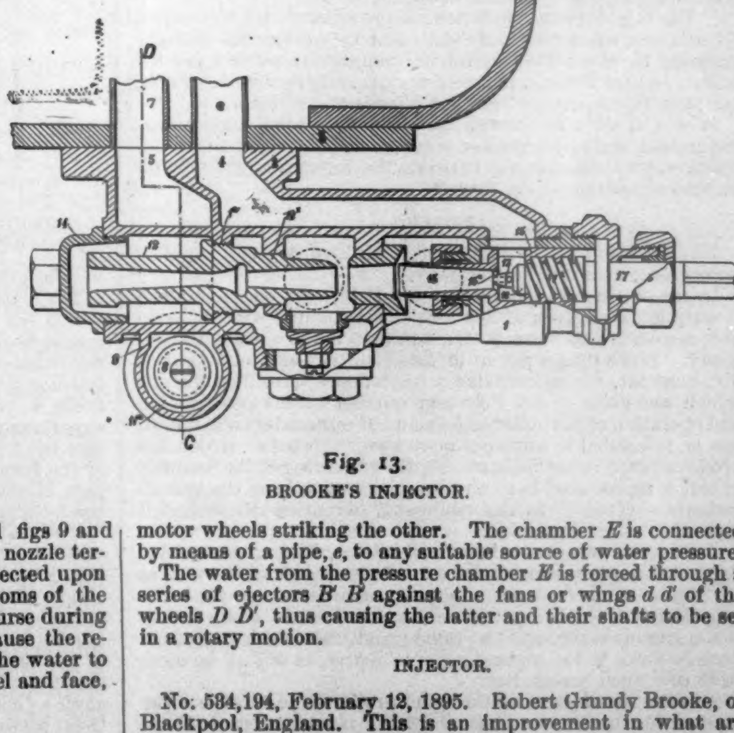


Fig. 13.

BROOKE'S INJECTOR.

INJECTOR.

No. 534,194, February 12, 1895. Robert Grundy Brooke, of Blackpool, England. This is an improvement in what are known as combination injectors, in which several boiler fittings, usually separate and distinct from the injector, are combined in the one apparatus. An object of this invention is to construct an injector of the type referred to in such a manner

that it can be conveniently fixed to any part of the boiler, and so that its various parts can be more conveniently taken apart than has hitherto been usual. For this purpose the injector is constructed with a self-contained non-return or check valve, having its case so formed and arranged in relation to a specially formed delivery passage that the seat of the said valve, as well as the valve itself, can be made removable without breaking any of the injector joints or connections; that the injector can be fixed with its body near to the boiler shell; and that the combining and delivery nozzles can, if desired, be readily withdrawn from the delivery end of the injector casing.

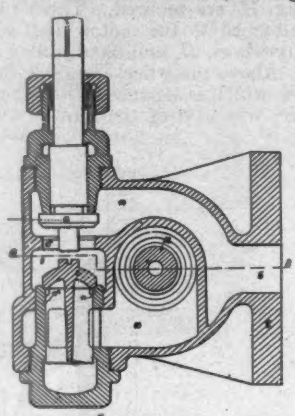


Fig. 14.

BROOKE'S INJECTOR.

Fig. 13 is a horizontal section on the line *A B* of fig. 14, and fig. 14 is a vertical cross-section on the line *D C* of fig. 13.

The inventor describes his invention as follows:

"1 is the injector casing formed with a flange, 2, by means of which it can be fixed to a boiler shell, 3, with its steam inlet 4 and delivery outlet 5 directly opposite steam and delivery pipes 6 and 7 respectively arranged within the boiler and so that the body of the injector can be close up to the boiler.

"8 is the self-contained non-return or check valve arranged within a case, 9, and serving to check the return flow of water through the specially constructed delivery passage 10. 11 is the valve seat.

"The valve case is arranged at the side of the injector casing away from the flange 2, and the delivery passage 10 is arranged transversely to the delivery nozzle 12, so that the water from the delivery nozzle will first pass outwardly and away from the final delivery outlet 5 until it passes through the valve case 9, whence it will pass back in a direction toward the final delivery outlet and thence into the boiler. By this construction it will be seen that the valve seat 11 for the non-return valve 8 can be formed on a tubular part, 11ª, adapted to be screwed into the bottom of the valve case, so that the valve seat and the non return valve can be readily removed for refacing or other purpose and then be replaced without breaking any of the injector joints or connections.

"The injector may, as shown, be provided with a stop valve, 13, adapted when moved on to its seat 13ª to close the delivery passage 10 at a point between the non-return valve 8 and the boiler, so that the said non-return valve, together with its seat, can then be removed while the boiler is under steam."

It would seem as though it would be a more compact arrangement and give greater security against accident if the check-valve 8 was placed between the injector and the boiler instead of outside of the former.

BOILER.

No. 534,673, February 26, 1895. William Schmidt, of Wilhelmshöhe, near Cassel, Germany.

In the AMERICAN ENGINEER for February, on page 89, a description was given of Schmidt's boiler and of some remarkable results which were attained in tests made with it in Germany. Since then a patent in this country has been issued to Mr. Schmidt, which contains a fuller description than the one which was given in our February number of the construction and operation of his boiler. As many of our readers will doubtless be interested in knowing more about this boiler, which has produced such remarkable results, the engraving of the Schmidt patent is reproduced here and literal extracts from the specification are given. In describing his invention Mr. Schmidt says:

"The purposes of the improvement are, first, to control the degree of superheating by means of the regulator, as well as by means of a feed-water heater; second, to prevent the superheater from being exposed to the furnace gases before steam can flow through the same; and, third, to exhaust the furnace gases to the highest possible degree, as will all be more fully described hereinafter.

"In fig. 15 *a* designates the boiler proper, *b* the furnace, *c* the passage for the furnace gases, *d* a flue arranged centrally above passage *c*, and *e* a casing held by the boiler *a*.

"The superheater *f*, which consists of a column of flat, horizontal coils, is arranged within the annular space between the flue *d* and the casing *e*, and communicates with the boiler *a* by the bent pipe *f'*. The steam thus flows through the coils *f* in the same direction as in the furnace, so that the wet steam, on being acted on by the hottest gases of the furnace, is first dried, and is thereafter superheated. The superheated steam escapes at f^2.

"The feed-water heater *g* consists likewise of a column of flat, horizontal coils, and is arranged above the superheater within the annular space between tube *d* and casing *e*. The feed-water enters the coils *g* at the upper end g^2 of the latter, and flows to the boiler *a* through the connecting-pipe g^3. It will be seen that the feed-water, contrary to the steam, flows in a direction opposite to that of the furnace gases. The latter are thus acting first on that part of the feed-water which has already been heated, while the cold water is subjected to those gases which are nearly wholly exhausted.

A small space is left between the superheater and the feed-water heater, and at that place the tube *d* is provided with a number of apertures, *d'*. Said apertures may be closed by a circular slide, *h*, which is connected with a lever, *i*, by means of a rod, *k*. The latter has a collar, *k'*, by means of which may be raised the lid *l* that is closing the upper end of flue *d*. It will be seen that lid *l* can be raised only after the apertures *d'* have been freed from slide *h*. This arrangement now works as follows: Suppose that all parts be in the position shown in the drawings, and the boiler be fully at work, the steam flowing through the superheater will be dried and superheated by the furnace gases that pass through the annular space between flue *d* and casing *e*. The furnace gases are hindered from escaping through flue *d* directly to the chimney *m*, as a lid, *l*, as well as the apertures *d'* are closed. If now from any cause the superheating of the steam becomes too great, the slide *h* is raised by means of lever *i*, so that the apertures *d'* become free of said slide. The furnace gases, instead of passing through the space containing the superheater, will then pass through the lower half of flue *d*, and will flow from thence through the apertures *d'* to and through the space containing the feed-water heater, so that the heating of the feed-water is increased, the superheating of the steam however decreased. As a matter of course the superheater need not wholly be deprived of the action of the heat, but only as much as necessary to reduce the superheating to its normal degree. The slide *h* therefore is raised only as little as necessary to obtain that result. It will be seen that the action of the furnace gases upon the superheater and the feed-water heater may be regulated in any required degree by correspondingly adjusting the said slide *h*. If the furnace gases shall be hindered to act even on the feed-water, the lever *i* is raised still more, so that lid *l* is lifted by means of the collar *k'* or rod *k*. Nearly the whole amount of the furnace gases is passing then straightway through the central flue *d* and up into the chimney *m*, so that during that time there is practically neither a heating of the feed-water nor a superheating of the steam. It will be seen that also in this case the lid *l* may be raised but very little at first, so that part of the furnace gases is escaping directly into the chimney and part of the same on the by-way through the space containing the feed-water heater.

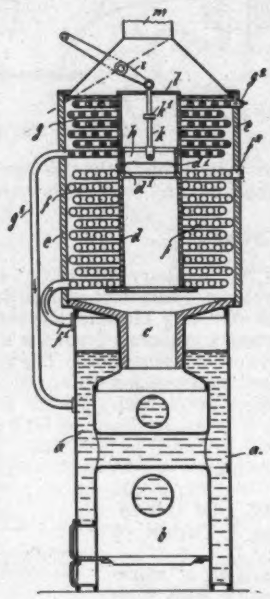


Fig. 15.

SCHMIDT'S SUPERHEATED STEAM BOILER.

"When the fuel in the furnace has been kindled anew the position of the lid is that last described—*i.e.*, the lid is fully raised so that the gases coming from the furnace *b* may freely escape into the chimney without being able to act on the two columns of the pipes *f* and *g*. This is of great importance in that as there is no steam yet within the superheater, the latter is prevented from being overheated. As soon, however, as the steam has reached the required tension for the respective engine, communication (which has been interrupted up to then) between the boiler proper and the superheater is established, so that the latter becomes filled with steam, and the lid *l* and slide *h* are lowered down to the position shown in the drawings, when the whole apparatus will commence to work as described."

AERONAUTICS.

UNDER this heading we shall hereafter publish all matter relating to the interesting subject of Aerial Navigation, a branch of engineering which is rapidly increasing in general interest. Mr. O. Chanute, C.E., of Chicago, has consented to act as Associate Editor for this department and will be a frequent contributor to it.

Readers of this department are requested to send the names and addresses of persons interested in the subject of Aeronautics to the publisher of THE AMERICAN ENGINEER.

THE LILIENTHAL FLYING MACHINE.

HERR LILIENTHAL, of Berlin, has for many years past been working at the problem of flight, and as he now seems to be fairly successful, an account of his apparatus and the method of using it will perhaps be of general interest.

He has constructed two machines—one for soaring flight only, the other with a carbonic-acid motor for rowing flight. He kindly showed me both of them at his practice ground, near Berlin, with the method of using them and allowed me to try the soaring machine myself.

Previous to constructing his machines, Herr Lilienthal tried a number of experiments to ascertain the pressure and line of action of the air on surfaces of different shapes. His experiments are fully described in his book, "Der Vogelflug als Grundlage der Fliegekunst," but the following are the principal results from them :

1. Soaring flight can be successfully accomplished without motive power, provided there is wind. The birds, when soaring, do not expend any power, all their movements being due to their own weight and the force of the wind.
2. Experiments with small rotating apparatus give far smaller wind pressures than experiments conducted in the open against the moving air.
3. With plane surfaces there is much less lifting power than with slightly curved surfaces.
4. The line of action of the resultant air pressure is not normal to the surface of a plane or to the chord of a curved surface, but varies greatly according to the angle of inclination of the surface. With curved surfaces, at small angles, it acts forward of the normal.
5. Repeated experiments show that the wind does not flow horizontally, but has a slight trend upward of about 3°. In warm weather this angle may be very much increased.
6. When the wind is blowing directly against the machine, the lifting power is largely increased.
7. When the wind is moving in the same direction as the machine, the latter must move faster than the wind, or it will be forced downward.
8. Although it is possible to proceed in any direction by soaring flight only, such a process will generally be very slow, and it is consequently desirable to have a motor powerful enough to drive a machine in a given direction without soaring.
9. A man is not powerful enough to work a wing-flapping machine under all circumstances.
10. Only the outer half of a wing should flap, the inner half being for sustaining and not for driving.

Herr Lilienthal has up to the present constructed two machines, and he is now constructing a third one of a slightly improved pattern. His first machine is for soaring only ; it weighs 40 lbs., and he has succeeded in soaring flight very fairly well. His longest flight was about 400 yds., and he has been 200 ft. up in the air. His second machine is very similar to the first, but the outer halves of the wings feather, and it is fitted with a small carbonic-acid motor weighing 40 lbs., capable of working the machine for about one and one-half hours on a fair day. The machines are made of willow and canvas, the willow being bent into the necessary shapes to suit the curvature. The arching of the wings is one-eighteenth of the spread at the deepest part, running out to nothing at the wing tips. The outer halves of the wings move through an angle of about 30° ; there is no hinge, only the spring of the wood.

Both machines are very neatly made, all the attachments being very carefully designed. Most of the guys underneath are of wire ; those above and connecting the tail are of stout cord.

The new machine will be very like the second one, but the surface will be slightly larger, the machine itself rather lighter, and the wing tips will work on a hinge. The piston-rods will be attached to the wing levers directly, and not by chains and pulleys, as in the second machine.

Herr Lilienthal's practice ground is at Lichterfelde, about 7 miles from Berlin. The hill from which he takes a preliminary run is about 150 ft. high, with an average slope of $\frac{1}{4}$. Four yards around the top is a grassy slope ; the remainder of the slope is covered with sand, in case of accidents. The first thing to be learnt is how to use the machine without a motor, and a good deal of practice is required to get off the ground and keep one's balance when in the air.

Starting.—Stand on the top of the hillock, facing the wind, and hold the machine so that the wings are about level. Then take a sharp run downward for about 4 or 5 yds., and you will feel yourself rise in the air and float gently down the slope, the inclination of which will depend on the force of the wind ; the legs to be kept well to the front.

Moving to Right or Left.—Throw the weight of the body toward the direction it is intended to move.

Coming Down.—In coming down, when the feet are about 3 ft. from the ground, throw the legs and weight generally well back and tip the wings backward.

A good deal of practice is required to use the machine well. Herr Lilienthal is very expert at it ; on a perfectly calm day he glided downward a distance of about 90 yds. As regards using the motor, this was tried for the first time on the day of my visit ; only one or two flaps were given, as Herr Lilienthal is very rightly very cautious when trying anything new. The movement of the wing tips did not in any way disturb the equilibrium.

The following appear to be the principal points to be attended to when practising :

1. A beginner should commence on a day when there is very little wind. He should not start from any great height. I commenced by starting from a point about one-fourth of the way up the hillock, and gradually worked up to a point about 6 yds. from the top.
2. It is necessary to take a good sharp run.
3. The machine should fit the operator, just as a bicycle should have dimensions suited to the person using it. I found this particular machine rather awkward to hold, as the arm rests were too big for me.
4. It is not safe to practise in a breeze of more than about 22 miles per hour with such light machines. If the wind exceeds the above, greater weight should be taken up, in what proportion, however, has not yet been determined.
5. No difficult feats should be attempted at first. What is wanted is to learn the use of the machine, and get accustomed to being in the air.
6. Gusty weather is specially dangerous, as it makes keeping the equilibrium very difficult.
7. Until the operator is well accustomed to the use of his machine, he should not attempt turning round to move with the wind. When turning, wide sweeping circles should be used.
8. When landing, the weight should be well thrown back, the object being, of course, to stop the forward velocity.
9. The manœuvres performed by birds should be carefully studied.

The following works contain a good deal of information about Herr Lilienthal's work, and are well worth studying :

1. "Der Vogelflug als Grundlage der Fliegekunst." Von Otto Lilienthal, Berlin, 1889.
2. "Progress in Flying Machines." By O. Chanute, C.E., New York, THE AMERICAN ENGINEER AND RAILROAD JOURNAL.
3. "The Proceedings of the German Aeronautical Society." Berlin.
4. *Prometheus*, weekly Berlin scientific paper.

J. D. FULLERTON, *Major, R. E.*

CHATTENDEN, November 14, 1894.

—Royal Engineers' Journal.

HARGRAVE'S RECENT EXPERIMENTS.

MR. LAWRENCE HARGRAVE, of Stanwell Park, Clifton, New South Wales (after many preliminary experiments) has now been building and sailing models of flying machines since 1885. He first built 10 machines driven by india-rubber bands in tension, with which he obtained a maximum flight of 270 ft. He next built six machines driven by compressed air, the

best of which flew 312 ft. (No. 14), and is now in the Field Columbian Museum at Chicago. Then he constructed two model machines driven by steam (Nos. 17 and 18), and although no very long flights were obtained with them, he satisfied himself that sufficient power could be carried to insure flights of a mile or more by steam, could the equilibrium be insured for such considerable distances in the open air.

Mr. Hargrave accordingly next turned his attention to the question of automatic equilibrium under varying conditions of wind, and in 1893 he produced his "cellular kites," described and illustrated in a paper contributed to the Conference on Aerial Navigation at Chicago (August, 1893), which paper has been published in AERONAUTICS and in the proceedings of the conference.

It seemed clear to Mr. Hargrave that if he and his motor and propeller mounted on a cellular kite, or a gang of them, could be safely raised from the ground in a wind and steadily fly, restrained by the kite line, then, by exerting sufficient thrust through a propeller of some sort, to slacken the line, he would to all intents and purposes be flying at the velocity of the wind; so that if he then slipped his moorings he could probably fly to leeward at twice the velocity of the then prevailing wind.

During the last 18 months Mr. Hargrave has greatly simplified and improved these cellular kites, and they are no longer the crude affairs described in 1893. They are now provided with two central longitudinal spines or booms, one over the other, and these chords are trussed together, thus forming a stiff vertical frame to which the cells are attached. The latter are made to fold up like an umbrella, so that the kites can be furled into a space equal to their length multiplied by their depth. This is accomplished by providing diagonal struts inside the cells, with a hinge at one end and an angle-iron shoe at the other. These shoes slide along the top and bottom members of the longitudinal trussed frame, and either brace out the cells or, when slipped out, allow the outer corners to come inward and the kite to furl, as indicated by the figure *C* in the accompanying engraving.

When the kite is furled the central main frame is somewhat limber sidewise, but when the cells are strutted out they act as bracing cantilevers and the whole structure is rigid.

The frame is all made of American red wood and the cells are of inferior calico; the top and bottom are stretched transversely to the line of motion by curved ribs, so as to present a concavo convex surface to the air.

These cellular kites are said by Mr. Hargrave to be perfectly stable and certain in their action, and to need no careful adjustment. They are raised with common clothes lines—three-rope yarn manilla—which is not easy to handle when under strain.

Mr. Hargrave has provided himself with five of these kites. These are shown in the engraving, not as they are grouped in actual flight, but when brought together under a tree on a still day for purposes of photographing. Their weights and dimensions are given in detail in the table herewith:

SIZES AND WEIGHTS HARGRAVE CELLULAR KITES, 1894.

KITE.	Length of each cell.	Breadth of each cell.	Depth of each cell.	Distance between the cells.	Distance from the forward end of the forward cell to the point of attachment of the kite string.	Weight of the kite.	Lifting surface of the kite.
A	1′ 11"	5′ 0"	1′ 10⅛"	2′ 1"	1′ 7"	5 lbs. 7oz.	38.5sq.ft
B	1′ 11"	5′ 0"	1′ 10½"	2′ 4"	1" 7"	5 " 14 "	38.5 "
C	2′ 8"	7′ 8⅛"	1′ 10¼"	4′ 5"	2′ 8"	9 " 8 "	69 "
D	2′ 6"	6′ 6"	2′ 3½"	3′ 6"	2′ 3"	9 " 0 "	65 "
E	2′ 6"	9′ 0"	2′ 6"	4′ 0"	2′ 10"	14 " 8 "	90 "

Now that the Australian summer has come, Mr. Hargrave has begun experimenting with these kites. He had an assistant, but says that under more favorable circumstances as to locality, and with a winch on the sling seat, he could readily dispense with aid.

On November 12, 1894, the outfit shown in the engraving was carried to the sea beach, and kites *A B* and *C* were raised. *C* proved to be weak at one corner, and the right-hand side of the forward section collapsed. This did not prevent it from still flying steadily, aided by *A* and *B*, but it was taken down, kite *D* substituted and kite *E* was added and raised.

Kites *A B D* and *E* were then flying in tandem on the same line, the distances apart being as follows: *A* to *B*, 52 ft.; *B* to *D*, 46 ft.; *D* to *E*, 46 ft.; while from *E* to the ground the distance was 6 ft., and it was secured by a gun tackle purchase to the spring balance and the two sacks of sand shown in the engraving. The group of kites was then pulling 180 lbs.

The sling seat was then toggled on, and Mr. Hargrave got aboard, with a hand anemometer to measure the speed of the wind and a clinometer to measure the angles of incidence. The assistant then slacked away the tackle line to the end. The apparatus was then 42 ft. to the leeward of the sand bags and veering with the wind round an arc of 40°. This was unexpected, as the wind was well to the eastward of south-southeast and the coast-line trends north-northeast and south-southwest. At this stage of the proceedings there were only a few pounds of the total weight unsupported by the kites, the feet of Mr. Hargrave being still on the ground. The velocity of the wind was 14.7 miles per hour, the pull on the spring balance was 120 lbs., and the slope of kite *E* with the horizon was 15°.

Thus matters continued for about a quarter of an hour, when the wind freshened and raised Mr. Hargrave from the ground. The velocity of the wind was then measured at 18.6 miles per hour, the spring balance reading 180 lbs.

Then the wind slacked off and lowered Mr. Hargrave back to earth. Several wind puffs next occurred, and ascents were made, but not of sufficient duration to read the anemometer, which is equipped with a two-minute sand-glass.

At length a long and strong wind gust arrived, and Mr. Hargrave went up like a shot. A careful reading of the anemometer showed the wind velocity to be 21 miles per hour, and the pull on the spring balance was 240 lbs.

The total weight raised and sustained aloft was then:

The four kites *A B D* and *E*	35 lbs.
The Toggles, lines, anemometer, sling seat	7 "
Mr. Hargrave	166 "
Total	208 "

which were supported by the 232 sq. ft. of lifting surface in the four kites, or at the rate of 0.90 lbs. per square foot; this being 41 per cent of the 2.2 lbs. of pressure to the square foot, corresponding to a wind of 21 miles per hour.

The angle of incidence of kite *E* was 15°, and that of *A B* and *D* was about the same; the angle measured from *E* to the kites above being nearly 60°, and the forward end of the cells being partly open to view. The angle of the tackle line may be said to have been 35° with the horizon.

The height of the sling seat above the ground was 16 ft., and on coming down Mr. Hargrave was enabled to haul himself and the kites to the moorings without leaving the seat. The line leading from this seat to the forward end of kite *E* is intended to allow the operator to cause the kite to tilt forward, thus advancing the position of the centre of gravity and diminishing the "lift" so as to come down gently. On this occasion this operation was unnecessary, as the wind slacked off during every ascent, and the operator always alighted very softly.

The altitudes attained were not great, but Mr. Hargrave says that the conditions would have been identical if the kites had been restrained by a mile of piano wire instead of the clothes line. He thinks that this experiment marks an epoch in his work, and that the entire steadiness of the apparatus in the wind establishes two facts:

1. That this extremely cheap, simple and compact apparatus can be made, carried about and flown by one man; and

2. That a safe means of either lifting up a flying machine from the ground, suspended to the kites, or of turning the latter into the flying machine itself, and, after adding a motor, making an ascent; of trying the apparatus without any risk of accident; and of coming down gently, is now at the service of any experimenter who wishes to use it, for Mr. Hargrave takes out no patents, and throws open his work to other aviators in order to expedite joint progress.

THE HIGHEST BALLOON ASCENSION.

IN this journal for March, at page 145, Professor Berson, of Berlin, gives some facts regarding the highest point attained by Glaisher in his ascension of September 5, 1862, and also regarding his own high ascension in Berlin on December 4, 1894.

There has been so much misunderstanding in regard to Glaisher's memorable ascension that I am sure a careful study of the facts may well be published at this time. Glaisher himself laid claim to a height of 37,000 ft., but as he was unconscious at about 26,000 ft. we must accept this with great caution. The French have placed Glaisher's height at 29,000 ft., and now Professor Berson places it at 27,900 ft. I have made strenuous efforts to obtain, though without avail, the

weight of balloon and appurtenances with the passengers; also to obtain the lifting power of the gas, which was the last that comes off in the distillation from coal, but could hardly lift more than 45 lbs. to the 1,000 cub. ft. A careful study of the meagre facts which have been published has shown that the gas used could not possibly carry the balloon to any such height as claimed. Glaisher's claim rests upon a certain supposed rate of ascent when he became unconscious, and his rate of descent when he recovered consciousness. I have found, however, that a balloon never starts back at once, even though the valve has been pulled; and for this reason most of the time while Glaisher was unconscious was spent in going horizontally. This is borne out all the more by the fact that Coxwell, the aeronaut, was paralyzed in all muscles except his neck, and the slight opening, if any at all, caused by pulling the rope in his teeth would not release much gas. Here are the facts:

Glaisher's last reading before becoming partly unconscious gave 26,350 ft. as the height, and a temperature of about —4°. A previous reading at 23,380 ft. gave a temperature of 8°. This shows a fall of 3° per 1,000 ft. A very delicate minimum thermometer, which had been accurately tested, gave —12° at the highest point, and, adding the 2,667 ft. indicated by this to the previous reading, we have 29,017 ft. as the highest point attained. Allowing full effect to Glaisher's claims, I am sure that the evidence is conclusive that the height was between 29,000 ft. and 29,500 ft.

Professor Berson's last reading showed the barometer 9.12 in. and temperature —54°. If we consider that all the errors in the barometer and thermometer had been allowed for, and also that the temperature at the earth was 37° and air pressure 30.02 in., we have a height of about 28,750 ft. as the highest made in this voyage. This is without doubt the highest elevation at which accurate observations have been made, and was possible in this case only because of the supply of oxygen carried up.

There is a slight misprint in the account on page 146, where it is stated that the mercury in the barometer froze at —20°. Every one knows that mercury freezes at —40°. It seems strange that the balloon in this case was filled full of gas at starting, as this would necessitate taking up more than 1,000 lbs. of ballast, all of which would have to be emptied with some exertion. If the start had been made with a balloon one-third full, the same height could have been reached without exertion, and the aeronaut would have been in a condition to rise 3,000 ft. higher, as he himself suggests.

H. A. HAZEN.

March 9, 1895.

HARGRAVE'S RECENT EXPERIMENTS WITH KITES.

AERONAUTICAL NOTES.

Proposed Aerial Bicycles.—A German manufacturer has produced a bicycle driven by a gasoline engine, which is said to travel at the rate of 31 miles per hour. A French inventor has also completed a somewhat similar machine, and the French aviators are discussing the best way of availing of these motors in flying-machine experiments.

French Exposition of 1900.—A sub "committee on aerostation," under the presidency of Commandant Renard, is discussing plans for bringing about an international exhibition of aeronautical apparatus. It is proposed to include not only

balloons of all kinds, but also flying and soaring machines, and to open the competition to foreigners upon the same terms as to the French exhibitors.

This committee, however, in discussing its plans, has felt it its duty to call the attention of the governing authorities to the danger, as regards national defence, of allowing photographs to be taken of navigable balloons in the air, and to suggest that regulations shall be adopted "to prevent abuses in this respect."

This seems to indicate that Commandant Renard desires to exhibit the French military balloon under full headway, but is apprehensive that some of his secrets might be surprised.

The Last of the Antwerp Balloon.—We published in the AMERICAN ENGINEER for October, 1894, the descriptions and illustrations of the proposed navigable balloon which was expected to form one of the attractions to the Antwerp Exhibition. This, it will be remembered, was to travel along a suspended cable, the driving screw taking its power from an electric trolley. Many unfortunate delays had occurred, but it was still hoped to get into operation before the close of the Exhibition.

These hopes proved futile. After spending six months and a good deal of money in the endeavor to get the enterprise in working order, the skin of the balloon was found to be so weak as to lead to continual rents and consequent escapes of gas. These were patched from time to time, and the balloon was filled about three quarters full and allowed to rise; but one end rose higher than the other, the balloon practically stood on its head, and the sun heating the contained gas at the stern, the balloon burst like a bomb. This is the end of the enterprise.

Steam Propulsion and Aerial Navigation Foretold by Roger Bacon in 1618.—A correspondent, M. de Fonvielle, calls the attention of the editor of *Nature* to one of Roger Bacon's essays, published in 1618, in which some of the possibilities of steam are vaguely foreshadowed, and aerial navigation is declared to be a thing of the future. The following quotation is from a translation which he furnished to that paper, and which reads like Mother Shipton's prophecies: "Instruments may be made for navigating without any men pulling the oars, with a single man governing, and going quicker than if they were full of pulling men. Wagons also can be made so that without any horse they should be moved with such a velocity that it is impossible to measure it. . . . It is possible also to devise instruments for flying, such that a man being in the centre if revolving something by which artificial wings are made to beat the air in the fashion of the birds. . . . It is also possible to devise instruments which will permit persons to walk on the bottom of the sea. . . . All these things have been done in old times and in our times, except the instrument for flying, which I have not seen, and I have not known any man who saw it done."

A New Dirigible Balloon.—The French newspaper *Patrie* of November 27, 1894, reports that experiments have just begun near Paris with a new dirigible balloon, the invention of Mr. H. Gadiffert.

It is stated to be of cigar shape and of 50,000 cub. ft. capacity, being somewhat similar to the Renard and Krebs military balloon *La France*, which, it will be recollected, was of 65,000 cub. ft. capacity. The mode of construction, however, is different, the net being replaced by a light cuirass of aluminum, to which are attached the various lines which suspend the car. The balloon is equipped with two propelling screws, one on each side, of novel design (which the inventor terms "accumulators"), being shaped much like an ordinary funnel for decanting liquids. These screws are driven by belts, leading to a winch in the car, and can be rotated in either direction, this being effected by handpower for the present.

Around the borders of the car a narrow aeroplane, which the inventor terms an "arrow," is attached. It can be detached or adjusted at various angles at will, and is expected to give the apparatus an upward or a downward direction under flight, in accordance with the angle of incidence presented.

During the first trial in November this aeroplane was not attached for prudential reasons, but the screws were relied upon both to propel and to change the direction of flight. The balloon was inflated with ordinary coal gas, and went up with three passengers. It rose quite rapidly some 2,600 ft., and then one of the screws was brought into action, whereupon the balloon turned around one and one half times upon a vertical axis, and took a position quartering with the wind, which position it maintained until ready to land. When both the screws were brought into action the apparatus attained an altitude of about 4,600 ft., without throwing out any ballast. Repeated trials having apparently indicated that the balloon readily responded to the action of this new form of screw, the aeronauts descended as night approached, and when near the ground brought the balloon head on to the wind by means of one of the screws, thus effecting a safe landing.

It is expected that further experiments will be made as the weather permits, probably next spring.

In the absence of precise data as to the relative speeds attained and the power applied, it is difficult to pass judgment upon the merits of this new proposal. The chances are that, like its many predecessors, it will prove inadequate to stemming brisk, ordinary winds; but it is possible that there may be some merit in the design of the screws, and that the aeroplane, when attached, shall give some control over the up or down direction, thus economizing ballast and gas, and prolonging the trips. It may safely be predicted, however, that whatever may be its merits for war purposes, this new dirigible balloon cannot attain commercial speeds, or carrying capacity, without resorting to enormous dimensions, even greater than those of transatlantic steamers.

Life-Saving Balloons.—Recently Professor Carl Meyers has completed at the balloon farm at Frankfort, N. Y., the first of a series of balloon outfits to be supplied to some 60 vessels belonging to New York parties for life-saving purposes in case of shipwreck. Each outfit consists of an automatic apparatus generating hydrogen gas under pressure, so controlled by a stop-cock that the closing of this immediately stops the generation or flow of gas and retains it still under pressure. This is used to rapidly inflate a balloon of sufficient size to carry a life line ashore from a wrecked vessel by means of which a heavier cable may be drawn for communication or passage of crew or goods as now practised by the governmental life-saving crews where stations exist for throwing a line by use of a mortar. The defects of the mortar system are that the stations are infrequent on the coast, the difficulty great in throwing a line against the wind at so small a mark as a ship, and the distance which frequently makes such efforts futile. The balloon system has the advantage of requiring no special apparatus on shore, while the balloon simply is drifted toward a line of coast by the same wind which blows the ship ashore, and drops its line when the shore is reached.—*Utica Observer.*

RECENT AERONAUTICAL PUBLICATIONS.

A New Flying Machine. H. S. Maxim. *Century Magazine*, January, 1895. An illustrated description of his machine by the inventor.

The Oakes Scheme. E. Oakes. *Danville* (Ill.) *Daily News*, November 10, 1894. An essay on the flying machine, proposing a combination of a balloon with aeroplanes.

Flying Apparatus. Otto Lilienthal. *Zeitschrift für Luftschiffahrt und Physic der Atmosphere*, June, 1894. A general discussion of the designing and experimenting of soaring devices.

Experiments in Aeronautics. H. S. Maxim. *Journal of the Society of Arts*, London, November, 30, 1894. An interesting lecture by Mr. Maxim, giving full details of his machine and experiments.

An Interview with Mr. Maxim. J. B. Smith. *The Strand Magazine*, London, December, 1894. An illustrated interview with Mr. Maxim, giving quite a full account of his various inventions and achievements.

Atmospheric Resistance. Professor W. L. Webb. *Proceedings Engineers' Club of Philadelphia*, November, 1894. An account of experiments to determine the resistance of the atmosphere to the free fall of spheres.

Progress in the Development of Flying Machines. M. Maclean. *Glasgow Philosophical Society*, December, 1894. A lecture giving an account of what has been attempted and accomplished with aviating machines.

Flying Machines. Prince Kropotkin. *The Nineteenth Century*, December, 1894. In reviewing advances in recent science, Prince Kropotkin notices the great strides made toward the solution of the aeronautical problem during the last few years.

The Aeronautical Annual. James Means. *W. B. Clarke & Co.*, Boston. 172 pp., price, $1. A compilation of some of the classics on the subject. Including extracts from Leonardo da Vinci, the essays of Sir George Cayley, of Thomas Walker, and of F. H. Wenham, the aeronautical correspondence of Franklin, some pamphlets by Mr. Means, bibliography of aeronautics, etc.